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PROJECT MISTT: MEASUREMENTS AND DATA BASE

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Project MISTT (Midwest Interstate Sulfur Transformation and Transport) was an EPA-sponsored research program of field measurements and data analyses carried out in the mid-seventies in the St. Louis region. The objective was to investigate quantitatively the dynamics and kinetics of sulfur compounds in the plumes of large power plants and of the St. Louis urban complex during their mesoscale transport. Major field programs were carried out in the summers of 1975 and 1976, involving the participation of about a dozen organizations from around the country. The main approach was to make detailed threedimensional measurements, both chemical and meteorological, primarily from instrumented airborne platforms, and including support from ground platforms. This report consists of three parts: Part I describes the platforms and the measurements; Part II gives a complete description and documentation of the General Distribution Data Base archived on magnetic tapes; and Part III is an unpublished Appendix providing a summary of each daily mission of the primary sampling aircraft for each of the two summer measurement periods.

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PREFACE

This report as originally prepared consisted of three volumes: Volume 1, describing the platforms and measurements; Volume 2, an appendix to Volume 1, listing mission summaries; and Volume 3, a description of the data base. Because the mission summaries are voluminous and of interest to only a limited number of readers, the appendix is not included in this publication; investigators who need the mission summaries may obtain a copy from the Project Officer.

In this report, Part I is the original Volume 1, Part I; Part II is the original Volume 3, Part II; and Part III is the unpublished Appendix A. Since Volumes 1 and 3 have been combined here so that the descriptions of the measurements and of the resultant data base are given in only one publication, the reader should ignore occasional usage of the volume numbers that pertained to the original reports preparation.

ABSTRACT

Project MISTT (Midwest Interstate Sulfur Transformation and Transport) was an EPA-sponsored research program of field measurements and data analyses carried out in the mid-seventies in the St. Louis region. The objective was to investigate quantitatively the dynamics and kinetics of sulfur compounds in the plumes of large power plants and of the St. Louis urban complex during their mesoscale transport. Major field programs were carried out in the summers of 1975 and 1976, involving the participation of about a dozen organizations from around the country. The main approach was to make detailed three-dimensional measurements, both chemical and meteorological, primarily from instrumented airborne platforms, and including support from ground platforms. This report consists of three parts: Part I describes the platforms and the measurements; Part II gives a complete description and documentation of the General Distribution Data Base archived on magnetic tapes; and Part III is an unpublished Appendix providing a summary of each daily mission of the primary sampling aircraft for each of the two summer measurement periods.

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LIST OF ABBREVIATIONS

ANL = Argonne National Laboratory

Battelle = Battelle Columbus Labs

CalTech = California Institute of Technology

CWPS = Cold Weather Plume Study

EMI = Environmental Measurements, Inc.

EPA = Environmental Protection Agency

ESRL = Environmental Sciences Research Laboratory

FSU = Florida State University

GDDB = General Distribution Data Base

MISTT = Midwest Interstate Sulfur Transformation and Transport

MRI = Meteorology Research, Inc.

NEROS = Northeast Regional Oxidant Study

PEPE = Persistent Elevated Pollution Episodes

RAMS = Regional Air Monitoring System

RAPS = Regional Air Pollution Study

Rockwell = Rockwell International Corporation

Sandia = Sandia National Laboratory

SRI = SRI International

STATE = Sulfur Transport and Transformation in the Environment

TPS = Tennessee Plume Study

UASN = Upper Air Sounding Network

UMinn = University of Minnesota

WSU = Washington State University

WU = Washington University in St. Louis

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The authors gratefully acknowledge the contributions of the many participants of Project MISTT who made the program a success. We particularly thank those individuals who, so long after the conclusion of the program, took the time and effort to dig back into their records to provide us with data and materials which form the substance of this report.

EXECUTIVE SUMMARY

Project MISTT (Midwest Interstate Sulfur Transformation and Transport) was principally an integrated, multidisciplinary, mesoscale field measurements and data analysis program, carried out in the St. Louis area in mid-1970s, under the sponsorship of the U. S. Environmental Protection Agency's Environmental Sciences Research Laboratories (EPA-ESRL). The immediate goal of the program was to quantify the dynamics (rates and mechanisms of transport and dispersion processes) and the kinetics (rates and mechanisms of the chemical transformation and removal processes) of sulfur emissions from large point and area sources such as power plants and urban-industrial complexes. The approach was centered around detailed, *in-situ* chemical and meteorological measurements within such plumes from instrumented aircraft, and with a wide variety of pertinent supporting chemical and meteorological measurements, both in-situ and remote-sensing, from surface platforms. All these measurements were to be made within the context of a co-ordinated experimental design, in an intensive mode, during field studies lasting about one month each. Such measurements, for practical reasons, were to cover a mesoscale range (typically < 200 km and < 10 h of plume transport). A broader, longer range, goal was to interpret the observed physical-chemical behavior of plumes as middle-ground or bridge between controlled laboratory studies of the fundamental processes on the one hand, and synoptic scale observations of secondary pollutant distributions, on the other. To this end, MISTT also supported laboratory studies and analyses of existing synoptic-scale data.

The measurement programs of Project MISTT proper took place in 1975 and 1976, principally during summer. MISTT evolved out of the earlier St. Louis Aerosol Characterization Study (1973,1974). This report pertains only to MISTT activities during the summers of 1975 and 1976. Project MISTT ran concurrently with another major St. Louis-based, EPA-sponsored, measurements program, viz. the Regional Air Pollution Study (RAPS). The RAPS program was more of a metropolitan-scale air pollution monitoring study, while MISTT was more a study devoted to investigating the processes influencing pollutant emissions during their downwind transport. The experimental design and plans of MISTT clearly presumed the support of RAPS in providing data related, in particular, to the emissions field, to local-scale ground-level pollutant distributions, and to prevailing meteorology. In this sense, MISTT and RAPS were complimentary studies.

Two major intensive summer field studies were carried out in MISTT, in 1975 and in 1976. Participation in these studies was broad, representing the government sector (EPA/RTP, EPA/Las Vegas and Argonne National Lab), the industrial sector (Battelle Columbus Labs, Environmental Measurements Inc., Meteorology Research Inc., Rockwell International, and SRI International), and universities (California Institute of Technology, Florida State University, University of Minnesota, Washington State University, and Washington University). The range of measurements was also broad, including field and laboratory measurements, airborne and surface measurements, in-situ and remote measurements, chemical and meteorological measurements, gas and aerosol measurements, meso- and micro- meteorological measurements.

The heart of MISTT measurements was the aircraft measurements program. In 1975, there was one primary sampling aircraft (MRI) and one "scout" aircraft (WU); in 1976, there were two primary sampling aircraft (MRI and WU) and a "scout" aircraft (EMI). The primary sampling aircraft measurements included gaseous parameters (SO_2, NO/NO_x, ozone, hydrocarbons/halocarbons), aerosol parameters (particulate sulfur, light scattering coefficient, aerosol charge, condensation nuclei count, detailed aerosol size distribution and chemical composition), meteorological parameters (temperature, humidity, turbulence), and of course, navigational parameters (time, altitude, VOR/DME, air speed, etc.). The desired goal in aircraft sampling was to perform three-dimensional plume mapping in a quasi-Lagrangian framework, involving detailed cross-sectional characterizations of a Lagrangian plume parcel at successive downwind distances. Such sampling was done to distances ranging up to 300 km, and generally in sufficient detail that rates and even mechanisms of gas-to-particle conversion of sulfur could be estimated with reasonable confidence.

One short-coming of MISTT was that no plans had been laid out, up front, to centralize the entire data base, and archive and document it as such immediately following the measurements programs. In general, each organization collected, processed, validated, and analyzed its own data. Only the primary aircraft data and the wind data were more widely used. Recently, an attempt was initiated to do the job of producing a unified, documented MISTT data base. The present report is the result of that initiative. The result of this long belated effort, we believe, is less than perfect, but more than adequate, to permit meaningful data analysis of the essential MISTT data base in the future. The final data base now exists in two forms - a General Distribution Data Base (GDDB) on magnetic tapes, and a less easily communicable hard copy data base consisting of reports and other publications.

The belated preparation of the GDDB has been accompanied by at least one redeeming feature. The preparation of GDDB/MISTT has proceeded more or less hand in hand with the preparation of similar GDDB's for three other major EPA-sponsored field measurement programs, viz. Project STATE-Tennessee Plume Study (TPS), Project PEPE/NEROS, and Project CWPS (Joint EPA/EPRI Cold Weather Plume Study). GDDB/MISTT has been completely unified in structure and format with the other GDDBs. *All* data files in GDDB/MISTT, and indeed almost all data files in the other GDDB's, have been cast into one or the other of two file formats. These formats are the STATE-20 (for time-series type of data) and the STATE-VS (for data of vertical soundings). Both of these formats are simple, sequential, 80 character card image formats which are designed for ease of use, and are essentially machine-independent. The familiar task of producing separate software to read each of many files in a large and varied data base is avoided here.

This report is presented in two parts. Part I describes the MISTT measurement programs of 1975, 1976 summers, and Part II gives a thorough documentation of GDDB/MISTT. Part I includes a clear definition of what measurements were made in each year, by whom, on what platform, using what instrumentation, and in what form (magtape and/or hard copy) and detail are the data available. To the extent that the data collecting organizations documented the quality assurance procedures and data quality assessments, these are either summarized or referenced in this report. The report attempts to avoid detailed duplication of what is available elsewhere, but that elsewhere is defined in this report in a section listing all major reports and publications directly related to MISTT which we could obtain. The main objective of this report is to familiarize anyone interested (not just MISTT participants) with MISTT activities and data, in sufficient (but not elaborate) detail, to direct them to specific parts of the overall data base (GDDB or hard copy or original source) which fall in their particular interest area. To this extent, Appendix A (Vol. 2) provides a mission-by-mission summary (flight map and outline flight log) of the activities of each primary sampling aircraft (MRI in 1975 and 1976, WU in 1976), as well as a meteorological summary for each day. In using these daily mission summaries, the reader must bear in mind that the activities of the other platforms were generally co-ordinated with the primary aircraft missions, unless they were conducting independent experiments.

Part II (Vol. 3) documents the GDDB of MISTT. It includes the data of the primary sampling aircraft (MRI and WU), the data reported by EMI (mobile gound lab in 1975 and airborne COSPEC data of the "scout" in 1976), the mobile pibal data reported by Rockwell (1975 and 1976), and the micrometeorological data of ANL (1975 and 1976). The data of the aircraft and the pibal are organized by mission. The data of the two years are separately presented. The GDDB data files are all in STATE-20 or STATE-VS formats; thorough descriptions of these file formats are included. Complete file directories are listed for each magnetic tape in GDDB, and for each type of file (i.e. representing the data of a given platform), a sufficient dump is given to show file header, file comments, and sample data records. File headers and comments are self-documenting. Part II has appendices which give information related to the data in the GDDB, but not available anywhere else. For example, the results of the analysis of MRI aircraft filter samples for particulate sulfur are not in the data files. These are fully tabulated, for all missions and all analyzed samples, in an appendix. Also, the aircraft position data are in VOR/DME, but the data files contain no or insufficient information concerning the ground VOR station relative to which the VOR/DME data are referenced. The VOR station information for all times of all missions is given in another appendix. Part II is expected to accompany the GDDB data tapes in future data distribution. It is all that will be needed by the users to use the GDDB.

Project MISTT was an outstandingly successful scientific study, with dividents and results which in several respects went beyond expectations. The authors of this report have used the data base extensively, but continue to marvel at the new insights revealed by the data at each successive use of the data base, whenever such use is motivated by specific questions. We have no doubt at all that future users will find answers to many new questions in this data base. We heartily encourage its use for many more years to come. In case of problems in the use of the data base, or if you have questions concerning MISTT data, please feel free to contact

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PART I - THE MEASUREMENTS PROGRAM

1. INTRODUCTION

Plume studies were an important feature of air pollution research in the United States during the decade 1970-79. They involved intensive field programs of airborne and ground measurements of a variety of chemical and meteorological variables for the specific purpose of investigating rates and mechanisms of the physical-chemical processes acting on emissions from large point and area sources during their atmospheric transmission. In particular, the transport, chemical transformation, and removal of *sulfur* compounds in plumes originating from sources in the *St. Louis* metropolitan area were the subject of quite concentrated study as a result of EPA's decision to base two major research programs in that city. Those two programs were RAPS (The St. Louis Regional Air Pollution Study) and MISTT (Midwest Interstate Sulfur Transformation and Transport), and they were conducted more or less contemporarily during the mid-seventies. RAPS was a comprehensive program for monitoring urban air quality and meteorology continuously over a period of about three years (mid-1974 through mid-1977). The routine measurements of RAPS were augmented during certain intensive periods by many special experiments. MISTT was principally a plume study in which multiple measurement platforms, instrumented and operated by different organizations, were deployed in more or less coordinated experiments conducted during intensive periods lasting a few weeks at a time. The summer intensive periods of RAPS and MISTT generally overlapped.

This report describes the MISTT measurement programs of the summers of 1975 and 1976. Each of these intensive periods lasted about four weeks. Specifically, this report includes:

1. A brief program overview, including identification of the participants and their functions, and an overview of the experimental missions in each summer intensive.

2. A brief description of the major platforms, their instrumentation packages, the measured variables, and where possible, some assessment of data quality.

3. A summary of each daily mission, including the flight maps and outlines of the primary sampling aircraft missions, and a daily summary of meteorological conditions is included in an Appendix.

4. Certain components of the RAPS data base are critically complementary to the MISTT data base. Specifically, the data of the RAMS surface network, the Upper Air Sounding Network, and the helicopter missions corresponding to the MISTT intensive periods, and the RAPS emissions inventory data, fall in this category. Consequently, a brief section outlining these RAPS activities, and the contents and availability of the corresponding RAPS data, is included in this report.

5. Finally, a list of available MISTT-related reports and publications is also included.

Project MISTT formally commenced around the beginning of 1975 under the sponsorship of the Aerosol Research Branch (ARB) of EPA's Environmental Sciences Research Laboratory (ESRL) in Research Triangle Park, North Carolina. MISTT evolved from the earlier St. Louis Aerosol Characterization Studies of 1973 and 1974, which were sponsored by the predecessor of the Aerosol Research Branch and involved participation of the same core group of scientists. The 1973 study was very brief and exploratory (WU: Husar et al, 1974)(*), with only three proper measurement missions. The 1974 study was broadened significantly in scope and measurements (WU: Husar, 1974), and had ten days of measurements. An excellent report describing the principal measurements and results of the 1974 study is available (MRI: White et al, 1976). A graphical data volume of the aircraft data is also available (MRI: Blumenthal et al, 1975). In MISTT proper, two intensive field measurement programs were conducted, in July-August 1975, and in July-August 1976. In addition, some limited, isolated, special experiments involving single platforms were carried out during the winters of 1975 and 1976. This report is limited to a discussion of the two summer programs.

Project MISTT was a well-conceived, well-planned, and well-executed field program; the scientific results of MISTT have been outstanding. As an early plume study involving the participation of multiple and diverse groups, however, it had one significant shortcoming. No advance plans were made for the aggregation and archival of a centralized, documented data base of all activities. Each participating group collected and processed its own data, and in most cases also analyzed and interpreted its own specialized data. The exchange of data was limited largely between three core participating groups (Meteorology Research, Inc., University of Minnesota, and Washington University), and included mainly the data of the primary sampling aircraft and the wind measurements. These exchanges were mainly informal. EPA's decision to commission the principal author of this report to compile, document, and report the available data base was recent indeed, and considerable difficulty was encountered in this belated venture. Consequently, the data base, as submitted here, is somewhat incomplete and deficient. Nevertheless, the present data base includes the core components which are likely to be of broadest interest, and for those components, it is sufficiently complete and well-enough documented to be quite useful.

(*) References of MISTT publications are listed in Chapter 5 by organization. The appropriate organization is identified (e.g. WU in this case) at the point of reference. References to non-MISTT publications lack designation of organization and are given as footnotes on the same page.

2. PROGRAM OVERVIEW

2.1 Scope of MISTT 1975 and 1976 Field Programs

Project MISTT was, above all, a plume study devoted to:

a) detailed sampling, particularly from instrumented airborne platforms, in the urban plume of St. Louis and in the plumes of specific large St. Louis sources of atmospheric sulfur

b) appropriate supporting measurements of background air quality and prevailing meteorology.

The principal specific target plumes in MISTT were those of the Labadie and Portage des Sioux power plants, and of the Wood River petroleum refinery complex (see Figs. 1, 2, and Table 1). The choice of St. Louis as the site of MISTT operations was based on the following major factors:

a) Metropolitan St. Louis is a major urban-industrial center, with a population exceeding two million, and has a major petroleum refinery complex with aggregate capacity of 4.4×10^5 barrels per day, and a variety of heavy industry;

b) the area has several large coal-fired central power-generating stations with aggregate capacity of 4600 MWe, half of it being concentrated in the Labadie plant with 700 foot high stacks;

c) St. Louis is an isolated city whose emissions may be tracked and studied over long distances without interference with other large plumes; and

d) the terrain surrounding St. Louis is relatively flat and agricultural, thus permitting more reliable and easier data interpretation.

The spatial-temporal scales of the plume sampling missions evolved to cover the mesoscale range upto 300 km downwind of the target sources. The study, however, also included measurements at the micrometeorological and synoptic scales. The choice of the name MISTT (probably near the end of 1974), with its clear identification of the spatial scale of interest ("Midwest Interstate"), was indeed foresighted and ambitious. Prior to 1975, the downwind range to which St. Louis plumes had been observed was much shorter. In 1971 and 1972, as part of the FAPS (Fate of Atmospheric Pollutants Study) program of NCAR (National Center for Atmospheric Research), the St. Louis urban plume had been identified in airborne and surface Eulerian measurements at downwind distances up to 120 km (Stampfer and Anderson, 1975).(*) The measurements, however, were not comprehensive

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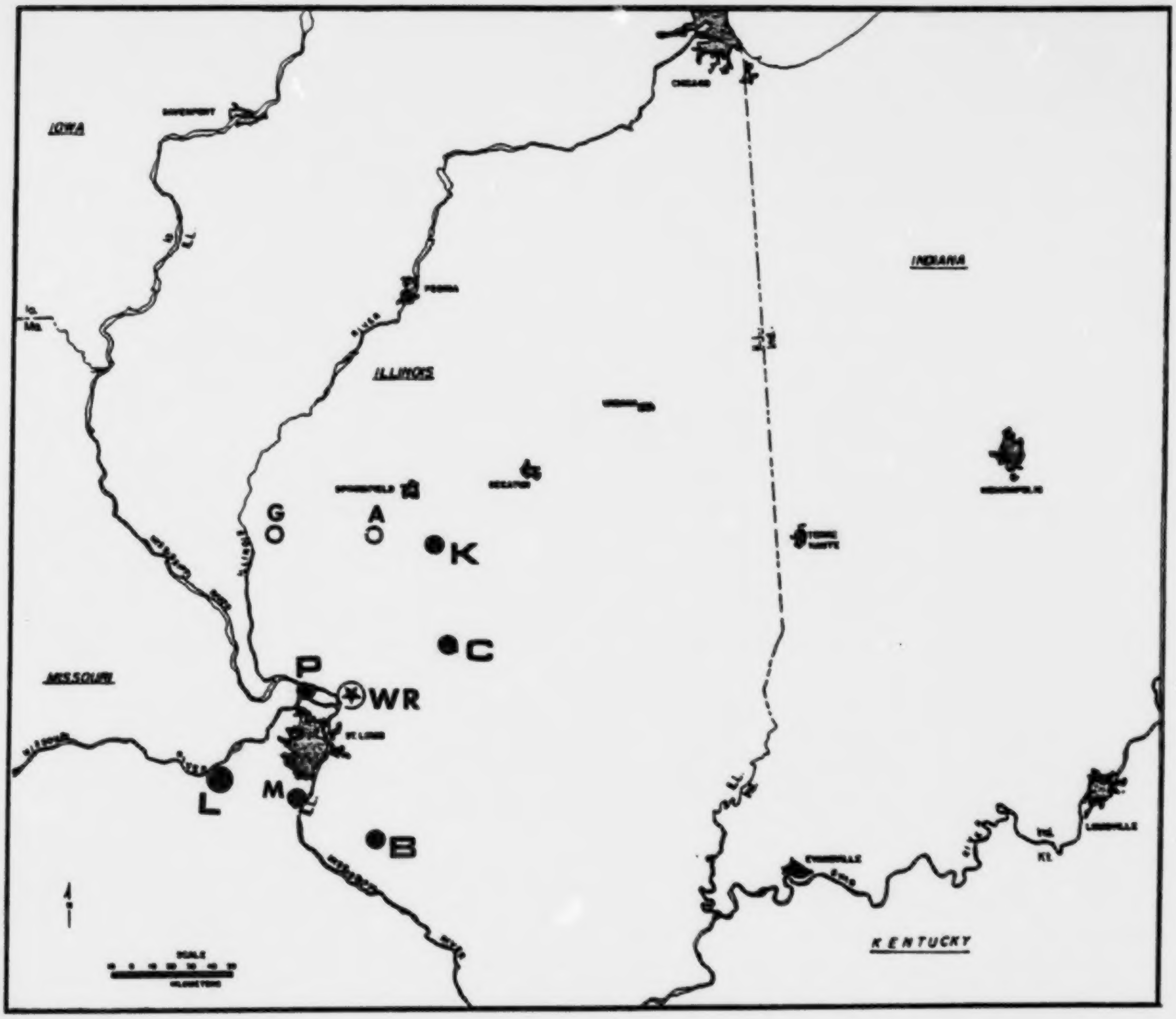
(*) Stampfer J.F. and J.A. Anderson (1975). "Locating the St. Louis urban plume at 80 and 120 km, and some of its characteristics," Atmospheric Environment Vol. 9, 301-313.



LEGEND

Power Plants: L = Labadie C = Coffeen M = Meramac
B = Baldwin P = Portage de Sioux K = Kincaid
Refinery Complex: WR = Wood River
Sampling Sites: A = Auburn, IL site of ANL Sangamon Experiment
G = Glasgow, IL site of EPA Trailer (1975)

FIGURE 1. Map showing Principal Sources of Sulfur Emissions in and near the St. Louis Metropolitan Area, and the Overall MISTT Sampling Region.

SPATIAL DISTRIBUTION OF EMISSIONS SOURCES IN METROPOLITAN ST. LOUIS (RAPS INVENTORY)

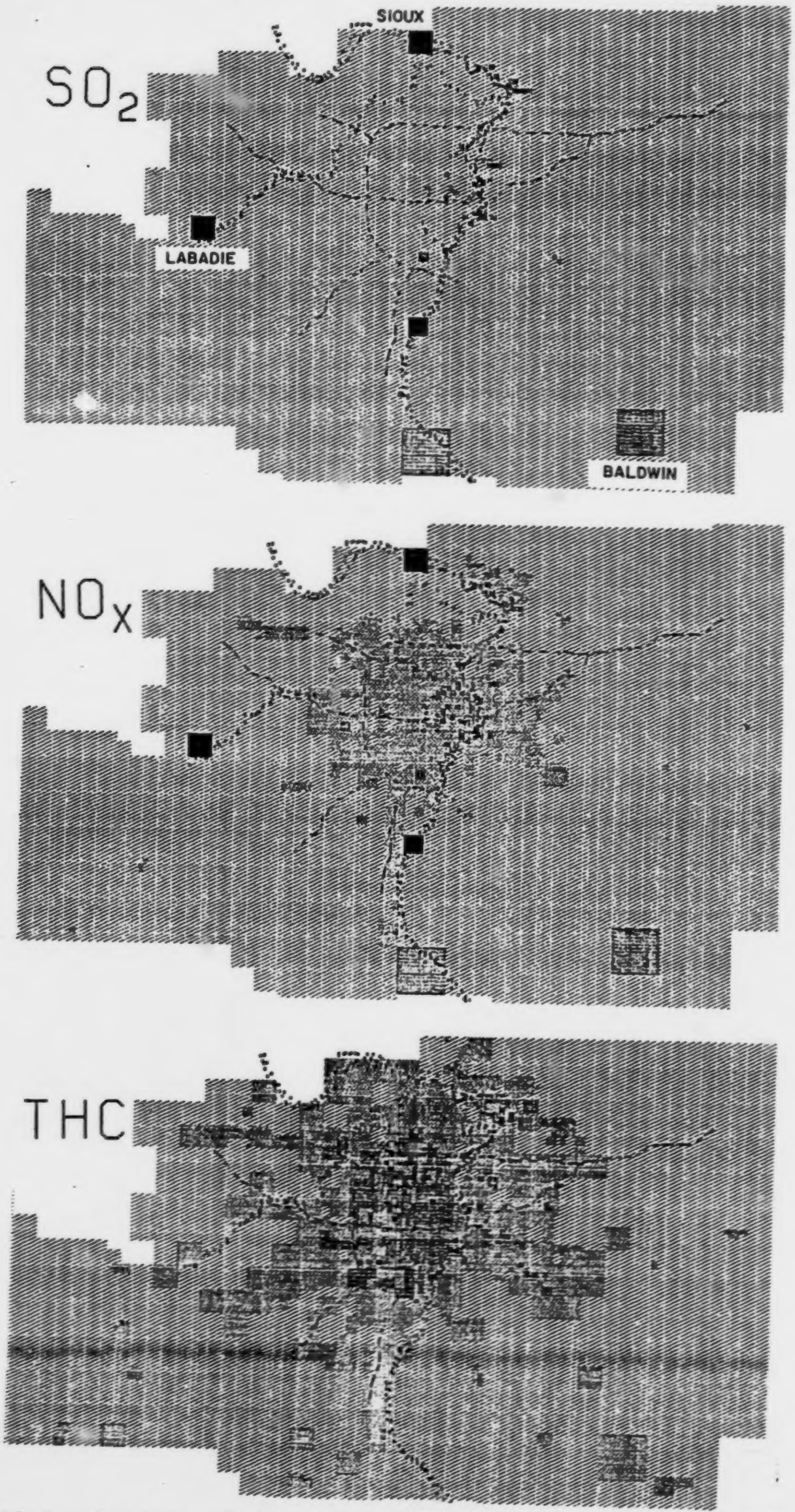


FIGURE 2. Gridded emissions of SO_2, NO_x, and THC (Total Hydrocarbons) in the St. Louis AQCR, based on the RAPS emissions inventory. Local fluxes are averaged over the grid squares.

TABLE 1

Some Features of Labadie and Portage des Sioux Power Plants[a]

Power Plant	Location [Lat/Long, Elev (m)]	Number of Boilers	Number of Stacks	Stack Heights (m)	Stack Exit I.D. (m)		Average Annual Sulfur (%) in Coal
					Stack #	I.D.	
1. Labadie	38° 33' N/90° 50' W 150 m	4	3[b]	All 213 m (700 ft)	1 & 2 3	6.25 m 8.84 m	3.0[c]
2. Portage des Sioux	38° 55' N/90° 27' 40" W 136 m	2	2	Both 183 m (600 ft)	1 & 2	5.72 m	3.0

---

a) Both plants are owned and operated by the Union Electric Company, are base-load, and coal-fired.

b) Boilers 1 & 2 feed separately into the two narrower stacks; boilers 3 & 4 share a single double-flue stack, with an equivalent diameter of 348" (8.84 m).

c) The average sulfur content of the coal burnt during the July 1976 field intensive period was closer to 3.2%.

enough to permit quantitative estimates of the rates of SO_2-to-sulfate conversion process, even though the overall rate of SO_2 loss from the plume could be estimated (Breeding et al, 1976).(*) In the 1974 St. Louis Aerosol Characterization Study of EPA, the measurements were more detailed, including those of SO_2 as well as aerosol sulfate, but the maximum downwind range covered in the ten plume sampling missions was only about 60 km. The stated goals for the 1975 MISTT program were also modest, a major "operational objective" being described as "the mapping of single power plant plumes in great detail and longest possible distances (up to 100 km)" in a report outlining the experimental design (WU:Husar, May 20, 1975). MISTT 1975 dramatically changed our expectations and hopes concerning the practical spatial scale of plume studies, with the 100 km goal being exceeded on 7 of 15 daily aircraft sampling missions, and the 200 km range being exceeded twice.

MISTT 1975 also brought with it, rather unexpectedly, the dawn of the era of regional haze research into the lives of MISTT participants. Perhaps the first seeds of PEPE/NEROS 1980 were sowed then also. During the July 29-30 urban plume sampling mission, we became acutely aware of the extreme intensity and multi-state spatial extent of a regional haze episode (nick-named "the blob"), and also simultaneously measured the highest ever observed concentrations of aerosol and sulfate mass in the St. Louis plume. It was at night, more than 200 km downwind. Coincidentally, that very day (July 29), a memo from Dr. A. P. Altshuller (then Acting Director of EPA-ESRL) to Dr. W. E. Wilson (then Acting Chief of ESRL's Aerosol Research Branch and Technical Director of MISTT) was dispatched to St. Louis, requesting a revision of MISTT plans to accommodate field tests of a hypothesis that observed high and uniform levels of ozone in slow-moving high pressure cells may be concurrent with similar disbribution of aerosol sulfate. This request was promptly met. The August 10 mission, known informally as the first "blob mission", sent the primary sampling aircraft chasing and sampling the blob from Wichita, Kansas to Indianapolis, Indiana. The extensive use by MISTTers in the late seventies, of the routine surface visibility observations as a tool in the study of spatial-temporal characteristics and long-term trends of atmospheric haze and sulfates also had its beginning on that day. A significant activity of MISTT following the summer of 1975 was related to this research.

By the time of planning for the 1976 MISTT field study, plume mapping out to several hundred kilometers was a clear operational objective. On two separate missions in 1976, sufficiently detailed plume measurements were made out to 300 km, permitting not only the estimation of the rates of secondary sulfate formation (WU: Gillani et al, 1978), but also the

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(*) Breeding R.J., H.B. Klonis, J.P. Lodge, J.B. Pate, D.C. Sheesley, T.R. Englert and D.R. Sears (1976). "Measurements of atmospheric pollutants in the St. Louis area," Atmospheric Environment Vol. 10, 181-194.

formulation of a quantitative relationship between this rate and the influencing factors, based on mechanistic considerations (WU: Gillani et al, 1981). The July 23-24 mission of 1976 marked another milestone. The da Vinci manned and instrumented balloon, embedded in the St. Louis plumes, served as a Lagrangian marker for the aircraft sampling (Sandia: Zak, 1981). The balloon and the sampling aircraft traveled with the St. Louis plume to Indiana. The 1976 MISTT measurement program ended with three regional experiments involving aircraft sampling.

While the focus of the measurement program of MISTT was on field studies in the real atmosphere, a significant effort was also devoted to development of improved instrumentation, and to controlled smog chamber experiments conducted under natural as well as simulated irradiation of outside air. Thus, MISTT was an integrated program in which the emphasis was on mesoscale plume studies in their role as a bridge between controlled laboratory simulations on the one side, and regional (synoptic) scale phenomena and processes on the other. To further the objective of such an integrated outlook, the sponsors and co-ordinators of MISTT took the initiative and role of organizer in staging the International Symposium on Sulfur in the Atmosphere in Dubrovnik, Yugoslavia in 1977. It marked the culmination and closure of Project MISTT. The Symposium was outstandingly successful in bringing together international experts on the subject, and in producing a published product (WU: Husar et al, 1978a), which is still one of the most prominent and broad-based sources of information on the subject of sulfur in the atmosphere.

A number of published reports and publications describe the specific scientific objectives, approach, experimental design, measurement strategies, and results of MISTT. This report does not wish to duplicate those reports. The emphasis here will be on defining and documenting the data collected and archived. A list of many of the MISTT-related reports and publications is included in the last chapter of this report. The reader is referred, in particular, to two overview reports by Wilson et al (EPA: 1977) and English et al (EPA: 1979).

2.2 MISTT Participants

Participants in MISTT were drawn from government, university, and industrial sectors. The principal participating organizations and their roles are identified on Table 2, along with year (1975) and/or 1976) of their participation. The program was under the overall management of the Aerosol Research Branch of EPA-ESRL, with Dr. William Wilson serving as Program Director. Washington University in St. Louis (WU) provided field management, with Dr. Rudolf Husar serving as the Field Co-ordinator. The Operations Headquarter (OHQ) and an on-site Data Center were also located at WU. The aircraft operations were based at the Spirit of St. Louis Airport in Chesterfield, Missouri.

During both years, the first seven organizations listed in Table 2 were the key participants, and the other seven were involved for certain special experiments or specialized supporting measurements in one or the other year. The data of the last seven organizations, where still

TABLE 2

MISTT 1975-76

Principal Participants

Organization	Function	1975	1976
1. Aerosol Research Branch, Environmental Sciences Research Lab, Environmental Protection Agency (EPA/ESRL/ARB - RTP)	1. Program management	X	X
	2. Air quality measurements and aerosol characterization (EPA trailer)	X	X
	3. Instrument calibrations support	-	X
2. Washington University (WU)	1. Field program direction	X	X
	2. Aircraft measurements	Scout	X
	3. Sulfate filter sample analysis	X	X
	4. On-site aircraft data processing	X	X
	5. Data interpretation and plume modeling	X	X
3. Meteorology Research, Inc. (MRI)	1. Aircraft measurements	X	X
	2. Meteorological consultation and data interpretation	X	X
4. Environmental Measurements, Inc. (EMI)	1. In-situ ground level air quality measurements and remote sensing COSPEC measurements (AQML)	X	-
	2. Airborne COSPEC measurements	-	X
5. University of Minnesota (UMinn)	1. Aerosol size distribution measurements in MRI aircraft and in EPA trailer	X	X
	2. Interpretation of aerosol data	X	X
6. Rockwell International (Rockwell)	Mobile pibal support	X	X
7. Argonne National Lab (ANL)	1. Boundary layer structure and dynamics measurements and interpretation (Sangamon Experiment)	X	X
	2. Surface flux measurements	X	X
8. Battelle Columbus Labs (Battelle)	1. Sampling and analysis (GC-MS) of urban organic vapors	X	-
	2. Outdoor smog chamber measurements of sulfate formation rates	-	X
9. Washington State University (WSU)	1. Hydrocarbon/halocarbon/ozone measurements (including detailed hydrocarbon speciation) at a rural site, and assessment of relative urban/rural contributions to ozone formation	X	-
	2. Analysis (detailed speciation) of hydrocarbons in grab samples collected in MRI aircraft	-	X
10. California Institute of Technology (CalTech)	Tracer studies of plume dispersion	X	-
11. Florida State University (FSU)	Time-sequence aerosol sampling (streakers) and elemental analysis (PIXE)	X	-
12. SRI International (SRI)	Surface mobil lidar measurements	-	X
13. EPA-EMSL, Las Vegas (EPA-LV)	Plume Tracking from airborne radar	X	-
14. Environmental Quality Research, Inc. (EQR)	Meteorological forecasting support	-	X

available, are only in report forms. Of the key organizations, MRI and WU provided the primary sampling aircraft and the key instrumentation. UMinn was responsible for the instrumentation for special aerosol measurements in the MRI aircraft and in the EPA Aerosol Trailer. In 1975, the EPA trailer was in Glasgow, Illinois, about 100 km NNW of St. Louis. UMinn and WSU performed the aerosol and the halocarbon/hydrocarbon measurements, respectively, at that site. EMI provided supporting in-situ and remote-sensing (COSPEC) chemical measurements from ground (1975) and airborne (1976) platforms. Rockwell provided the mobile pibal support as an extension of their RAPS activities. ANL performed micrometeorological and surface flux measurements at Auburn, Illinois, about 120 km NNE of St. Louis, as part of their larger Sangamon Field Experiment.

In 1975, there was one primary sampling aircraft, instrumented and operated by MRI, and also a scout aircraft, instrumented and operated by WU. The function of the scout was to locate and identify the target plume, determine its dimensions and special features, and in general provide advance information which served to plan, in an optimal fashion, the specific details of the mission of the MRI aircraft. The scout also served as an airborne communications relay station between OHQ in St. Louis and the MRI aircraft during the longer range missions. A distinguishing feature of MISTT field missions, and one which was a particularly significant factor in the success of the longer range missions, was that real-time mission direction was provided by scientists who designed the experiments and who later performed the data analyses. Such mission direction was exercised from the OHQ based on real-time data feed-back by radio communication from the key measurement platforms (especially the primary sampling aircraft and the mobile pibal teams).

In 1976, there were two primary sampling aircraft, the MRI aircraft and another one instrumented and operated by WU. The scouting function was partially performed by a third aircraft operated by EMI. During long range missions, the two primary sampling aircraft often operated in a leapfrog fashion with each aircraft making about four hours of quasi-Lagrangian sampling in the target plume air parcel before turning over the reins to the next aircraft which simply proceeded onward with the quasi-Lagrangian sampling. The aircraft concluding its session, in such cases, served the role of the scout for the other aircraft. The EMI scout aircraft was also instrumented with a COSPEC (correlation spectrometer). This aircraft flew as low as possible, in crosswind traverse, under or through the target plume, and made remote-sensing measurements of the integrated overhead SO_2 burden. Owing to the ability of the COSPEC to obtain a relatively rapid and integrated picture of the plume lateral distribution, it served a very useful role as the scout for the primary sampling aircraft.

The two most critical sets of measurements in MISTT, for the purpose of characterizing the transport and transformation of sulfur, were the aircraft chemical measurements and the definition of the prevailing flow field by way of pibal soundings (Rockwell). During the MISTT intensives, the RAPS upper air soundings also provided wind profile data at fixed sites in an Eulerian mode. The Rockwell mobile pibal soundings were more in the Lagrangian mode, co-ordinated in time and space with the current aircraft mission.

The chemical measurements included simultaneous measurements of both SO_2 and aerosol sulfate, the former continuously and the latter by way of filter samples. A new and sensitive sulfate analysis technique (flash-vaporization, flame-photometric detection) was modified to give short-time (5-20 min) resolution of aerosol sulfate collected on aircraft filter samples (WU: J. D. Husar et al, 1976). MISTT also supported work aimed at development of instrumentation for continuous *in-situ* measurement of particulate sulfur in the aircraft, and also for its speciation into strong and weak acidic components (WU: Cobourn et al, 1978). While such instrumentation was field tested in MISTT, it was not applied until later field studies. Detailed aerosol size distribution measurements were also made in the aircraft and on the ground to provide data for assessment of aerosol volume formation and aerosol growth dynamics (UMinn: Whitby et al, 1978; UMinn: Cantrell and Whitby, 1978). To characterize the coupling between sulfur and nitrogen-hydrocarbon-oxidant chemistry, measurements were also made of nitrogen oxides, hydrocarbon species, and ozone, both in the aircraft and in surface platforms.

2.3 MISTT Field Missions

The 1975 field study took place from July 16 through August 15, with 11 organizations being involved in the measurement program. Table 3 summarizes the days of participation of the various organizations. Table 4 summarizes the 15 primary sampling missions of the MRI aircraft in 1975. Eight of the 15 missions were devoted to urban plume studies, in which the aggregated St. Louis plumes were sampled at discrete downwind cross-sections to downwind ranges varying from 30 to 250 km. Six missions were focused on sampling downwind in the Labadie power plant plume. One mission (August 10) was the "blob mission". A mission-by-mission summary of the activities of the MRI primary sampling aircraft is given in Appendix A.1 (Vol. 2) of this report. In fact, that Appendis part is a reproduction of the entire Vol. 1 of MRI's report to EPA of its 1975 task (MRI: 1975). It includes for each daily aircraft mission, a weather summary, the aircraft flight map and an outline of the sampling events and their times. We feel that these daily summaries will give potential users of the MISTT data base the best indication of the focus of each mission, and thus a basis for selecting missions of greatest interest to their specific needs. Volume 2 of the MRI report is the 1975 Data Volume, and contains detailed tabulations of the aircraft data.

Table 2 summarizes the 17 sampling missions in 1975 of EMI's surface mobile lab (the AQML). Nine of these missions were in support of the primary aircraft missions (on July 17, 18, 19, 28, 29, and August 6, 7, 10, 12). The downwind range covered by AQML extended from 20 to 125 km from St. Louis.

The 1976 field study was scheduled to take place during the entire month of July. The WU aircraft, however, flew a mission as early as June 27, and flew three regional missions at the end (July 30, August 2 and 3), after the study was otherwise concluded. Table 6 summarizes the mission days of the 9 main participating groups. Tables 7 and 8 summarize respectively the primary sampling missions of the MRI and WU aircraft. MRI flew 14 missions including the da Vinci mission of July 23-24. Of the other 13, 3 were urban plume missions, 9 were power plant plume missions (mainly Labadie), and one (July 15) was directed at the Labadie and the urban plumes. The WU aircraft also flew 14 missions

TABLE 3

MISTT 1975

SUMMARY OF PLATFORM DEPLOYMENT

DATE:

PLATFORM:	July																August														
	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
MRI Aircraft		X	X	X		X		X	X-	X			X	X-	X							X	X-	X-	X	X	X	X	X		
WU Scout-Aircraft			X	X		X	X						X	X-	X		X			X	X	X	X	X-	X	X	X	X			
EMI AQML		X	X	X			X		X	X	X		X	X	X	X	X		X	X	X	X	X	X	X	X	X	X			
Rockwell Pibals		X	X	X		X	X		X	X	X		X	X	X					X	X	X	X	X	X		X		X		
EPA Aerosol Lab								?												X	X	X	X	X	X			?			
WSU HC - Sampling	X	X	X	X	X	X	X	X		X				X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
ANL Sangamon Expt.						X	X	X		X	X	X	X	X	X	X						X	X	X	X	X		X	X	X	
EPA - LV Lidar Aircraft																				X					?					X	
Battelle Organic Vapors (variable sites)													X		X						X			X							
FSU Streaker Sampling	X	X	X	X	X	X	X	X	X	X																					
CALTECH SF_6 -Tracer releases																								X	X		X	X	X		X

X- X indicates a mission started on the first day and continued into the next.

TABLE 4

MISTT 1975

MRI Aircraft

Summary of Sampling Missions

DATE	METRODATA CARTRIDGE(S)	TARGET PLUME	SAMPLING TIME	DOWNWIND RANGE (km)
July 17	120, 127	Urban	0732 - 1325	30
18	134, 135, 406	Urban	0701 - 1855	170
19	407	Labadie	0748 - 1406	40
21	415, 416	Urban	0711 - 1239	50
22	408, 409	Urban	0726 - 1411	110
24-25	417, 450	Labadie	2114 - 0435	145
28	452, 453	Urban	1311 - 1805	35
29-30	454-458	Urban	(29)1335 - 1125(30)	250
Aug 06	460	Labadie	1656 - 1930	40
07-08	461, 462	Labadie	1732 - 0111	80
08-09	420	Labadie	2208 - 0142	85
10	421, 419, 463	Regional (KAN, MO, ILL, IND)	0512 - 1750	Regional
11	418, 422, 423	Urban	0744 - 2131	220
12	426, 427	Urban	0800 - 1511	150
13	429	Labadie	0643 - 0946	25

TABLE 5

MISTT 1975

EMI - AQML

Summary of Sampling Missions

DATE	TARGET PLUME	SAMPLING TIME	DOWNWIND RANGE
July 17	Wood River	0816 - 1643	54 km
18	Wood River	0854 - 1807	60
19	Labadie	0935 - 1500	35
24	Wood River	0935 - 1700	20
25	Wood River	0912 - 1705	31
26	Labadie	1233 - 1608	25
28	Wood River	0845 - 1700	Data logger problems
29	Wood River	1000 - 1815	100
Aug 01	Wood River	0915 - 1705	65
03	Labadie	0956 - 1911	75
04	Labadie	0918 - 1822	120
05	Labadie	0830 - 1633	75
06	Labadie	0934 - 1820	75
07	Labadie	0738 - 2303	110
09	Wood River	0723 - 1503	8
10	Wide Area Survey	0820 - 0303	Ranging upto 125 km N, S, and W of St. Louis
12	Wood River	0700 - 1730	55

TABLE 6

MISTT 1976

SUMMARY OF PLATFORMS DEPLOYMENT

PLATFORM:	DATE: July 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
MRI Aircraft	X	X			X-	X	X					X		X	X			X		X			X-	X		X	X	X		X	
WU Aircraft(1)					X-	X	X		X			X	X	X	X			X		X			X-	X						X	
EMI COSPEC - Aircraft												X	X	X	X		X	X	X	X		X	X	X				X			
ROCKWELL Pibals	X	X			X	X	X		X			X		X	X			X		X		X	X	X		X		X		X	
EPA Aerosol Lab																?															
ANL Sangamon Expt.																X	X	X	X	X		X	X	X	X	X			X	X	
BATTELLE Outdoor Smog Chamber Expt.																						X	X			X	X	X		X	
SRI Lidar Van														X	X	X	X			X			X								
SANDIA da Vinci																							X-	X							

Missions also on June 27 and August 2,3
X- X indicates missions which started on the first day and continued into the next.

TABLE 7

MISTT 1976

MRI Aircraft

Summary of Sampling Missions

DATE	METRODATA CARTRIDGE(S)	TARGET PLUME	SAMPLING TIME	DOWNWIND RANGE (km)
July 01	602	Labadie	0827 - 1130	18
02	603, 604	Urban	0846 - 1636	80
05-06	605-608	Labadie	(05)1108 - 0446(06)	135
07	609, 610	Urban	0904 - 1802	70
12	611	Labadie	1355 - 1412(*)	-
14	613, 614	Labadie	0618 - 1423	50
15	616, 617	Urban & Labadie	0823 - 1518	70 (Labadie)
18	619-621	Labadie	0739 - 0031	300
20	622-624	Urban	1055 - 0030	170
23-24	625-629, 631	Urban (**)	(23)0429 - 1408(24)	500
26	632	Labadie	0415 - 0758	45
27	634	Labadie	1055 - 1202	25
28	635, 636	Labadie & Portage	0411 - 1253	30
30	637, 638	Labadie	0520 - 1513	45

(*) data logger malfunction; no data after 1412.

(**) This mission was a Lagrangian plume study co-ordinated with the Sandia DA VINCI III mission.

TABLE 8

MISTT 1976

WU Aircraft

Summary of Sampling Missions

DATE	METRODATA CARTRIDGE(S)	TARGET PLUME	SAMPLING TIME	DOWNWIND RANGE (km)
June 27	001	Urban	1650 - 2250	200
July 05-06	004, 005	Labadie	(05)1934 - 0501(06)	150
07	008	Urban	1040 - 1950	100
09	006, 007	Urban & Labadie	(09)0737 - 0344(10)	300 (Labadie)
12	009	Labadie	1341 - 1633	60
13	011	Labadie	1332 - 1455	30
14	012	Labadie	0527 - 1601	250
15	014	Urban & Labadie	0753 - 1647	100
18-19	013, 015	Labadie	1411 - 0238(19)	300
20	016	Wood River	1041 - 1303	30
23-24	019	Urban(*)	(23)1408 - 0746(24)	500
30	021	Regional "Blob" Study	1246 - 2051	MO-KY-IL-IN
Aug 02	022	Regional "Box" Study	1109 - 2053	MO-KY-TN-OH -IND-ILL
03	023	Urban (Louisville and Cincinnati)	1040 - 2117	170 (Louisville)

*This mission was a Langrangian plume study co-ordinated with the Sandia DA VINCI III mission.

including the da Vinci mission. Of the other 13, the last three were regional experiments, 3 were urban plume missions, 5 were exclusively Labadie missions, and two were missions directed at the juxtaposed separate plumes of Labadie and the rest of the urban complex. Eight of the missions of both aircraft were reasonably co-ordinated (July 5-6, 7, 12, 14, 15, 18, 20, 23-24). The maximum downwind range covered by each aircraft in plume missions was about 300 km. In Appendix I - 1976, we present daily mission summaries of the aircraft missions of 1976. The material is taken from the Data Volumes of the MRI and WU aircraft data (MRI: 1976; WU: 1976). The Appendix contains a meteorological overview for July 1976, followed by the daily mission summaries. For each mission day, we have included a weather summary, synoptic weather and air mass trajectory maps, tabulations of local meteorological conditions, and flight outlines and maps of the missions of the WU and MRI aircraft missions.

The emphasis in the 1975 study was more on urban plume missions. In 1976, the emphasis was shifted more in favor of the power plant plume missions. The da Vinci mission (July 23-24) was by far the single most elaborate mission of 1976 in terms of the number of participants and the degree of co-ordination from OHQ. The Sandia team actually involved much more than the da Vinci balloon (Sandia: Zak, 1981). The manned and instrumented balloon lifted off in the morning of July 23, lodged itself in the St. Louis plumes, and drifted downwind with them. The MRI, WU and EMI-COSPEC aircraft sampled the urban air, using the balloon as a Lagrangian marker. Around midnight, as the balloon approached Indianopolis, it deliberately changed course southward and out of the St. Louis plumes, in an attempt to avoid potential bad weather ahead. The balloon finally landed in Kentucky in the morning of July 24.

The July 23-24 mission was significant for another reason also. The WU aircraft had aboard it for this mission two ozone monitors - the DASIBI monitor normally used in the WU aircraft in 1976, and an REM monitor which is a chemiluminescent device similar to the one normally used in the MRI aircraft. Results of comparison of the two monitors are given in the summary of this mission in Appendix I - 1976.

Two other missions in 1976 need to be highlighted for instrumentation-related reasons. In the WU aircraft, a specially-adapted sulfur analyzer was being tested as a continuous monitor for *particulate* sulfur during the mission of July 13. This first test gave very encouraging results which are included in the summary of this mission in Appendix A.2 (Vol. 2). Such a continuous monitor performed as the primary sulfate sampler in STATE-TPS with distinction, and was further refined in PEPE/NEROS to provide, in the continuous mode, separately the strong and weak acidic components of ambient particulate sulfur. During the mission of July 15, the WU and MRI aircraft flew side-by-side during a crosswind plume traverse to provide a cross-comparison of the corresponding instrumentation in the two primary sampling platforms. This, of course, is of importance in the use of the data of the two aircraft in any data analyses of co-ordinated missions. Results are presented in this mission's summary in Appendix A.2 (Vol. 2).

Typically, in a given mission, the primary sampling aircraft repeated two-dimensional plume cross-sectional measurements at discrete sections at increasing downwind distances in a quasi-Lagrangian time frame. The objective of Lagrangian sampling, desirable for the study of plume kinetics, was frequently not realized, as some degree of compromise was necessary between this objective and the objective of measuring adequate cross-sectional detail. The latter objective called for continuous measurements during horizontal crosswind plume traverses at as many discrete heights as possible within the plume cross-section at a given downwind distance. Generally, the traverses at a given section were also preceded or followed by a vertical spiral through the plume and extending over a height including the bulk of the PBL and any capping elevated inversion layer. An example of a daytime cross-sectional mapping involving three traverses (one is partial) through the St. Louis plumes at different heights within the mixing layer, and a vertical spiral up beyond the mixing layer, is shown in Fig. 3. In the case of sampling of just a power plant plume, the crosswind spread is typically narrower, particularly at shorter downwind distances, and more traverses may be possible at each cross-section in a comparable amount of time.

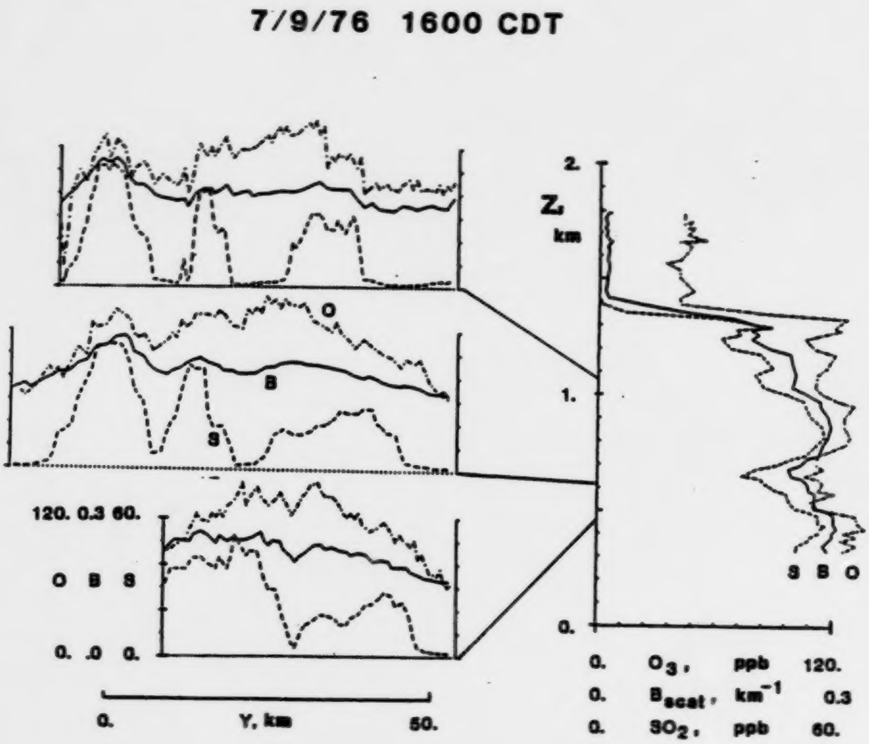

Figure 3. Cross-section of the St. Louis plume 75 km downwind of Gateway Arch on 9 July 1976. Crosswind profiles of ozone, B_{scat}, and SO_2 at three heights were measured in the WU aircraft between 1530 and 1645 CDT in three horizontal traverses (left) and spiral descent (right). Altitudes (msl) of the traverses are indicated on the plot of the spiral; location of the spiral was approximately at Y = 0. (WU: White et al, 1982).

3. THE MEASUREMENTS AND QUALITY ASSURANCE

3.1 Aircraft Measurements

The following aircraft platforms were deployed as part of MISTT:

1975 - MRI primary sampling aircraft
- WU scout aircraft
- EPA-LV lidar aircraft

1976 - MRI primary sampling aircraft
- WU primary sampling aircraft
- EMI COSPEC aircraft

This section describes the instrumentation and measurements in the above aircraft. The data of the continuously-monitored parameters in the primary sampling aircraft are archived. The data of the WU scout and the EPA-LV lidar are not archived in the final MISTT data base. The data of the COSPEC aircraft were recorded only on strip charts. A later EPA decision led to the digitization of the data of four airborne COSPEC missions; these data are included in the archived data base.

An important step in quality assurance of the data recorded continuously in the primary sampling aircraft was the procedure of rapid on-site computerization and review of the data. A data center at WU was dedicated to this purpose during the field studies. Built around a PDP-11 minicomputer system, and staffed by WU personnel, the data center received the raw data on METRODATA cartridges from the aircraft at the end of each mission, and immediately read the data into computer storage. The data were then converted to engineering units based on instrument calibrations available at the beginning of the field program. The results were plotted in graphical form and reviewed by MRI, WU and EPA scientists, normally prior to the next mission. Particularly during the first week of the field program, such data review revealed instrument malfunctions and other problems (e.g. radio interferences, etc.). Efforts were made immediately to correct such problems before subsequent missions. Also, flight logs were reviewed immediately after most missions to flag deficiencies in keeping flight notes. Finally, such on-site data review was combined with a process of past mission reviews to assess positive and negative points. Such reviews provided a mechanism of feedback to guide the planning and direction of future missions by scientists at OHQ.

3.1.1 MRI Aircraft

The MRI aircraft during both field studies was a Cessna 206. It was equipped to measure and record continuously the following variables:

Gas concentrations	:	SO_2, NO, NO_x (= NO + NO_2), O_3;
Aerosol Parameters	:	B_{scat} (light scattering coefficient), Charge (aerosol charge acceptance), CNC (condensation nuclei count);

Meteorological Parameters : Ambient temperature,
Dew-point temperature,
Turbulence (actually, $\varepsilon^{1/3}$, where ε = turbulent energy dissipation rate, and hence a measure of small scale turbulence);

Position Parameters : Altitude (barometric),
VOR/DME, i.e. the azimuthal angle from magnetic north and radial distance relative to a specific ground radar station (VORTAC). The current VORTAC station to which the aircraft was tuned was identified in the flight logs, and not continuously recorded.

In addition, time was also a continuously recorded parameter. The above set of measurements will henceforth be referred to as the standard MRI package.

The aircraft instrumentation also included a filter tape aerosol sampler to collect samples for *post-facto* chemical analysis to determine particulate sulfur mass in the sample. The flow rate of outside air passed through this sampler was also monitored. Hence the particulate sulfur concentration of the ambient air could be determined as an average over the integrated time of each sample. As a result of special efforts, this sampling time was minimized by adapting the flash-vaporization/FPD technique of sample analysis for high sensitivity. Also, an MRI airborne impactor system collected aerosol samples for determination of elemental composition of the aerosol, segregated by size.

The aircraft instrumentation package also included two aerosol size distribution analyzers supplied by, and operated for, the University of Minnesota team under the late Professor Kenneth Whitby. These analyzers were the Whitby electrical aerosol mobility analyzer (EAA) and an optical particle counter (OPC). The EAA and OPC resolved the aerosol size distribution in the range .006 - 4.5 μm into 11 discrete intervals. The two instruments drew their samples from a plastic bag which was filled with outside air at intervals of several minutes. The aerosol size distribution analysis by the instruments was completed immediately following the intake of the grab sample, and the bag was evacuated before the next sample intake.

Finally, in 1976, air samples for gas chromatographic analysis of hydrocarbons and halocarbons were also collected in stainless steel cannisters using a system designed at WSU. These samples were subsequently analyzed by WSU for detailed speciation of the organic vapors. Further discussion of the analysis methodology and data quality assessment are given under WSU later in this chapter. The results of these analyses are tabulated in the MRI 1976 Data Volume. Tables summarizing the month's data are included in Appendix A.2 (Vol. 2).

A detailed description of the MRI aircraft sampling system and instrumentation used in MISTT was given by Blumenthal et al (MRI: 1978). Table 9, taken from that reference, identifies the particular monitor

Table 9(*)

CESSNA 206 MEASUREMENT SYSTEMS

Parameter	Sampler Manufacturer and Model	Analysis Technique	Measurement Ranges	Time Response (to 90%)	Approximate Resolution
SO_2	Theta Sensors LS400	Electrochemical Cell	1.0*, 10.0 ppm	5-15 s	0.01 ppm
NO/NO_x	Monitor Labs 8440	Chemiluminescence	0.2, 0.5*, 1.0, 2.0, 5.0 ppm	5-10 s	0.01 ppm
O_3	REM 612	Chemiluminescence	0.5*, 2.0 ppm	5 s	0.005 ppm
Hydrocarbons, Halocarbons**	Washington State University	Stainless Steel Canisters/Gas Chromatography		20 s	~1 ppb ~1 ppt
Sulfate	MRI TWO-MASS (Prototype)	Flash vaporization/ flame photometric	<3 μm dia.	~10 min	~3 μgm^{-3}
Aerosol Composition***	MRI Airborne Impactor System	Microscopy, IEXE	3 stages & filter D_{50}'s ≈15, 3, 0.4 μm	10-30 min	
Light Scattering Coefficient	MRI 1550	Integrating Nephelometer	10*, 40 × $10^{-4} m^{-1}$	1 s	0.1 × $10^{-4} m^{-1}$
Aerosol Charge Acceptance***	Washington University	Ionizer/Electrometer	0.01-1.0 μm	3 s	
Condensation Nuclei	Environment One Rich 100	Light Attenuation	1, 3, 10, 30, 100*, 300*, 10K × 10^3 CN/CC	3 s	1000 CN/CC*
Aerosol Size Distribution	TSI 3030 Royco 218	Electrical Mobility Optical Particle Counter	0.006-1.0 μm dia. 1.0-4.5 μm dia.	3 min analysis time per distribution	
Turbulence	MRI 1120	Pressure Fluctuations	0-10 $cm^{2/3} s^{-1}$	3 s (to 60%)	0.1 $cm^{2/3} s^{-1}$
Temperature	YSI/MRI	Bead Thermistor/ Vortex Housing	-5° to +45°C	5 s	0.5°C
Dew Point***	Cambridge Systems 137	Cooled Mirror	-50° to +50°C	0.5 s/°C	0.5°C
Altitude	Validyne	Absolute Pressure Transducer	0-3000 m msl	1 s	6 m
Indicated Airspeed		Differential Pressure Transducer	20-65 ms^{-1}	1 s	0.1 ms^{-1}
Position	King KX170B/ Metrodata M8	Aircraft VOR/DME	0-75 km from station	1 s	1° (bearing), .2 km (distance)
Data Logger (includes time)	Metrodata 620		0-9.99 VDC	0.8 s/40 channel scan	0.01VDC
Stripchart Recorder**	Linear Instruments	Dual channel	.01, 0.1, 1, 10VDC	<1 s	

* - Usual Range(s)
** - 1976 only
*** - 1975, 76 only

(*) This table is taken from Blumenthal et al (MRI: 1978).

used for each measured parameter, the corresponding operational principle or technique of analysis of the instrument, its measurement range, response time, and approximate resolution. The above reference also gives information concerning the quality and accuracy of the data.

The continuous data were logged on tape cartridges of a Metrodata data logging system at the rate of 40 channels of data approximately once every second. The first 20 channels contained the continuous data of the MRI standard package, and the last 20 channels contained the discrete data pertaining to the aerosol size distribution measurements for UMinn. The first 20 channels of data were processed by MRI in the months following the field study period. Such processing included corrections for zero drift and changing calibrations. Continuous gas monitors were generally calibrated (multi-point) after each mission (for details, see MRI: Blumenthal et al, 1978). Other instruments were calibrated before and/or after the field study. According to Blumenthal et al, "In general, we believe that the accuracy of the data obtained by the aircraft system is comparable to that obtainable by most ground stations".

The archived data base (the General Distribution Data Base) includes only the continuous data of the MRI standard package. The aerosol size data have been analyzed and reported by UMinn. During the recent phase of compilation of the MISTT data base, the UMinn personnel were preoccupied on matters of higher priority, and could not provide sufficiently processed information suitable for archival. Consequently, the aerosol size data are not in the data base.

The time-integrated particulate sulfur data resulting from the FPD analysis of filter samples from the MRI aircraft are included in tabulated form in an appendix of Part II (Appendix B - S_p). There is no information available at this time concerning the aerosol composition based on the samples collected in the impactor system.

The continuous position data of the aircraft are included in the daily data files in three channels named ALTITUDE, VOR and DME. The VORTAC station information was not automatically recorded. We have scanned the original flight logs of each mission and have listed all the VORTACs contacted by the aircraft navigation system along with the corresponding time periods, in tabulated form. This table of VORTAC stations is included in Appendix C - VORTACs of Part II.

MRI printed hard copy data volumes for both 1975 and 1976. The 1975 data volume contains data tabulations, while the 1976 data volume contains data plots.

3.1.2 WU Aircraft

In 1975, WU instrumented a Rockwell Aerocommander with the following continuous monitors to perform the scouting functions:

- Theta Sensors SO_2 monitor
- MRI integrating nephelometer for B_{scat}
- Radioaltimeter
- VOR/DME navigation system.

In addition, the scout was also equipped with radio communications equipment to perform its communications relay functions. The scout served a very useful role as intended for it. Since it was not primarily intended as a sampling aircraft, its data were never fully processed and archived. The continuous data were, however, logged on a Metrodata data logger and subsequently computerized. The raw data are available at WU, but are not archived in the formal GDDB of MISTT.

In 1976, WU equipped a Rockwell 680 FL Aero-Grand Commander twin-engine aircraft as one of the two primary sampling aircraft. The instrumentation package is summarized in Table 10, and measured the following variables continuously every 2 s:

Gas concentrations	:	SO_2, O_3
Aerosol parameters	:	B_{scat}, Aerosol charge, CNC
Position parameters	:	Altitude, VOR/DME
Time		

The concentration of particulate sulfur was measured by collecting aerosol samples in a two-stage (< 3 μm and > 3 μm), filter tape system. Sample analysis was by the modified flash vaporization/FPD technique which gave sufficient sensitivity to permit sample times ranging from 5-20 minutes, depending on ambient aerosol concentration.

The data of the average particulate sulfur concentration over the sample time were inserted into the permanent continuous data files during data processing. Also the identification of the current VORTAC station to which the aircraft navigational system was tuned in has been inserted into the continuous data files as a VOR station code. The code interpretation is facilitated through a tabulation of the codes and corresponding VOR stations, which is included in Appendix C - VORTAC.

The gas analyzers were frequently calibrated during the field studies, and calibration corrections were subsequently made to the daily data during the data processing and validation stage. Instrument time response corrections were also applied to SO_2 where necessary, based on the method suggested by Markowski (MRI: 1975). Such correction depends not only on the instrument response time, but also on local gradients of the SO_2 concentration. The correction is significant only for aircraft traverses through coherent plumes with very high concentration gradients.

The WU aircraft data of every channel were reviewed in detail for quality assessment. Data corresponding to severe data logger malfunctions have been clipped out. Data of individual channels have been de-gliched if an obvious glich was present (e.g. due to radio transmission interference). Occasionally, some data of individual channels were invalidated owing to improper instrument range setting (resulting in pegged or out-of-range data) or due to instrument malfunction. In such cases, the data have been assigned very large negative values.

The quality of the corresponding WU and MRI aircraft data is believed to be comparable.

TABLE 10

MISTT 1976

WU AERO-GRAND-COMMANDER INSTRUMENTATION PACKAGE

MEASUREMENT MODE	PARAMETER	SAMPLER MANUFACTURER AND MODEL	ANALYSIS TECHNIQUE	INSTRUMENT TIME RESPONSE	MEASUREMENT RANGES	APPROXIMATE RESOLUTION
Continuous	SO_2	Meloy SA-285	FPD	5 s	50, 100, 500 ppb	1 ppb
	O_3	Dasibi 1003AAS	UV - absorption	5 s	200, 500 ppb	5 ppb
	Bscat	MRI 1550	Integrating nephelometer	1 s	10 ($10^{-4}m^{-1}$)	0.1 ($10^{-4}m^{-1}$)
	CNC	Environment One	Light attenuation	3 s	1, 3, 10, 30, 100, 300 (10^3 CN/CC)	1 (10^3 CN/CC)
	Aerosol charge acceptance	WU - Charger	Ionizer/Electrometer	1 s	α surface area of .05 - .2μm diameter particles	
	Altitude	Validyne	Absolute pressure transducer	1 s	0-3000m MSL	6m
	Position	King KX170B	Aircraft VOR/DME	1 s	0-75 km from station	1° VOR 1 km DME
	Time (and data logger)	Metrodata DL 640		2 s per 20 channel scan	0-9.99 VDC	.01 VDC
Integrated	Particulate Sulfur	TWOMASS (two-stage/ filter-tape sampler)	Flash vaporization/ FPD	5-20 min. sample time	<3μm aerosol >3μm aerosol	∿ 1μg/m^3

A more complete description of the WU aircraft operation and measurements is given in Appendix 1 of Husar et al (WU: 1978b). The complete WU aircraft data base is also presented in graphical form in a data volume (2 volumes).

3.1.3 EMI COSPEC Aircraft

In 1976, EMI partially took over the role of airborne scouting. Included in their aircraft was a correlation spectrometer (COSPEC) operated to monitor continuously (every 3 s) the overhead integrated SO_2 burden (ppm-m). The COSPEC was mounted in an upward-looking mode in the aircraft, which typically flew at 1200 ft MSL, or about 700 ft AGL. The continuous data were not automatically recorded on a magnetic medium, but were recorded on a strip-chart recorder. The data of four missions were assigned priority level 1, and were digitized. The digitized parameters included time, altitude, UTM-(x,y), and COSPEC-SO_2 burden. The UTM-(x,y) position parameters are in UTM zone 15. The data center at WU has converted these position data to LAT/LONG.

The four priority 1 missions were those on July 14, 18, 23 and 28. The first two missions have been high priority missions for all participating platforms and have received much attention in data analyses. The July 23 mission, the da Vinci mission, was also a high participation mission in which the airborne COSPEC played an important role. On July 28, the EMI and MRI aircraft flew a correlative mission in which the MRI aircraft made in-situ measurements during crosswind plume traverses at discrete heights ranging over much of the Labadie plume cross-section 30 km downwind of the source, while EMI made multiple traverses underneath the plume. The analysis of this correlative data comparing plume cross-sectional SO_2 integration from the two data sets may serve the role of assessment of the data quality of the COSPEC-SO_2. Until such assessment, the COSPEC data must be viewed with caution in quantitative analyses.

3.1.4 EPA-LV Lidar Aircraft

The downward-looking ruby laser lidar made remote-sensing measurements of the relative aerosol distribution in the PBL and in plumes during the last part of the 1975 program. The lidar was then still being tested as a remote-sensing tool for plume tracking. The data could not be obtained and are not part of the MISTT data base.

3.2 Ground-Level Chemical Measurements

3.2.1 EMI AQML

EMI's Air Quality Mobile Laboratory, a Dodge maxivan, was equipped with an array of monitors to make *in-situ* and remote-sensing measurements of gas concentrations and aerosol parameters during the 1975 field study. The outputs from these monitors were fed into a navigational data acquisition system which recorded the air quality and position data in UTM (Universal Transverse Mercator) co-ordinate system once every 10 sec on digital magnetic tape. The following continuous monitors constituted the instumentation package:

Gas Monitors:

- A COSPEC III (#5932) was utilized for monitoring in a continuous mode the vertically-integrated overhead burdens (ppm-m) of SO_2 and NO_2. Since the COSPEC utilizes attenuation of the near-UV spectrum of solar radiation for SO_2 sensing, and part of the visible spectrum for NO_2 sensing, it was mainly operated in the daylight hours between 0830 and 1700. The raw data of COSPEC-SO_2 are subject to two important sources of error. The instrument response to attenuation by SO_2 is non-linear particularly at values in excess of 500 ppm-m. Also, the scattering of near-UV radiation by atmospheric aerosol is quite significant. EMI performed elaborate and numerous calibrations of the instrument in an attempt to make appropriate corrections. The aerosol interference correction, however, was not based on current atmospheric turbidity, but rather on an observed general diurnal trend of the instrument sensitivity. Detailed discussion of quality assurance procedures is given in the EMI final report of this task (EMI: 1976).
- A Meloy SA-185 was used for ground level SO_2, and was calibrated 14 times during the field period (7/17-8/12).
- A Thermo Electron chemiluminescent monitor (TECO) was used for ground level NO_x. It was calibrated once midway through the study by the EPA audit team.

Aerosol Monitors:

- MRI 1550 integrating nephelometer was used for ground level B_{scat}. This nephelometer was equipped by WU with a heater to provide aerosol speciation by the technique of differential thermonephelometry (WU: Cobourn et al, 1978). The instrument was used in the heated mode only when the van was stationary. The nephelometer was calibrated once during the study.
- The WU Charger, an instrument most sensitive to the aerosol population in the size range .01 - .1 µm.

The reader is referred to the EMI final report (EMI: 1976) for more complete description of the instrumentation, the measurements, and the quality assurance procedures.

The AQML was also equipped with the TWOMASS aerosol sampler, similar to the one in the WU aircraft. The samples were analyzed by WU for particulate sulfur. The results are included in the EMI data volume.

The navigational data acquisition system logged the UTM x-y position co-ordinates. These were subsequently converted to LAT/LONG by EMI. Both sets of position co-ordinates are included in the data files which are archived in the final MISTT data base.

3.2.2 EPA Aerosol Trailer

In 1975, the EPA trailer sampled in stationary mode at a rural site near Glasgow, Illinois, about 100 km NNW of St. Louis (see map in Fig. 1). The trailer was instrumented to measure gaseous and particulate contaminants, as well as various surface meteorological parameters. The aerosol size distribution instruments were installed and operated by UMinn. The trailer was also the site for halocarbon and hydrocarbon sampling and analysis done by WSU (described later). The following measurements were made by EPA's Aerosol Research Branch in the trailer:

Gas:

SO_2 - Meloy SA-160 FPD monitor (detection limit 5 ppb), and Meloy SA-185 FPD monitor (detection limit 15 ppb).

NO/NO_x - TECO 14-B chemiluminescent analyzer (detection limit 1 ppb)

O_3 - Bendix 8100 chemiluminescent analyzer (detection limit 1 ppb)

THC, CO, CH_4- Beckman 6800 Air Quality Chromatograph utilizing a flame ionization detector. The lower detection limits were 0.05 ppm for THC and CH_4, and 0.2 ppm for THC and CH_4, and 0.2 ppm for CO.

Aerosol:

Aerosol size- Whitby EAA and OPC, as in the MRI aircraft

B_{scat} - MRI 1550 nephelometer

CNC - Environment/One Rich-100 CN counter

Particle composition and mass - High-volume filter samplers for TSP

- Anderson impactor, LBL dichotomous sampler, and Jensen Nelson streakers for samples for subsequent X-ray analyses

Meteorological:

Barometric pressure - Rosemont pressure sensor

Relative humidity - EG & G Vapormate II dew point sensor

Solar radiation - Two Eppley radiometers for broad-band and UV

Temperature, and wind speed/direction - Climet Meteorological System

Five-point calibrations of the gas monitors were performed before each sampling period.

In 1976, the EPA trailer made similar measurements (except for WSU part) at a site at the Spirit of St. Louis airport.

The data of both studies were recorded and stored on magnetic tapes, but could not be obtained by us. A publication by Ellestad (EPA: 1980) reporting on portions of these data and results of their analyses is available.

3.2.3 WSU Organic Vapors Measurements

Integrated quantitative gas chromatographic measurements of nearly one hundred individual hydrocarbons present in ambient air were made at the Glasgow, Illinois site (see Fig. 1) by WSU in 1975 to determine the total non-methane organic vapor burden. Halocarbons were also measured. These measurements were made in conjunction with those of ozone, NO_x, and meteorological variables. The objective was to study the transport and formation of oxidants in clean rural air as well as in air contaminated by anthropogenic urban emissions. Flurocarbon-11 was used as a tracer of anthropogenic emissions, and acetylene was also used as a secondary tracer.

WSU also performed the chemical analysis for hydrocarbons of the air samples (in stainless steel cannister) collected in the MRI aircraft in 1976.

The hydrocarbon analyses were performed using three Perkin-Elmer flame ionization gas chromatographs. One (the PE 990) analyzed hydrocarbons from butane through decane (C_4 - C_{10}); the second one (PE 3920) quantified hydrocarbons from ethane through hexane. The overlap in carbon number between the two instruments provided a check in determining actual concentrations of individual compounds. Total non-methane hydrocarbons were then determined by summing the C_2 through C_4 compounds on instrument two with the C_5 through C_{10} on instrument one. Instrument three (PE 3920) analyzed specifically for ethane, ethylene and acetylene, and provided another check on the precision between instruments. Calibration was accomplished using neohexane as an external standard.

Identification of the hydrocarbons was accomplished by periodically injecting a set of standard compounds and then matching their retention times with those from an actual sample. Those peaks with similar retention times were named accordingly. Occasionally, an actual sample was "spiked" with a standard to further support identification.

Halocarbon analyses were performed employing a PE 3920 electron capture (Ni 63) gas chromatograph. Calibration was accomplished by preparing known concentrations in static chamber in the home laboratory. Dilution of the appropriate amount of pure halocarbon species into the chambers gave concentrations simulating ambient air levels to a precision of ± 10%. Reference cannisters were then calibrated and shipped to the Glasgow field site for daily calibration of the instruments. Halocarbon identification was accomplished by matching retention times with standards.

Table 11, taken from Rasmussen et al (WSU: 1977), summarizes the C_2 - C_4 and C_5 - C_{10} hydrocarbon concentration totals for all analyses for the entire 1975 study. The Rasmussen et al report also gives tabulations of the detailed speciation results for hydrocarbons and halocarbons for each sampling day. During July 1975, there was a single 8-hour daytime sampling shift. During August, three shifts gave round-the-clock coverage.

TABLE 11(*)
MISTT 1975 - WSU

SUMMARY OF LIGHT AND HEAVY HYDROCARBON CONCENTRATIONS
IN SAMPLES COLLECTED IN GLASGOW, ILLINOIS

GLASGOW, ILL.

C_2 THRU C_4
C_5 THRU C_{10} in $\mu g/m^3$

	JULY 1975																AUGUST 1975													
	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	1	2	3	4	5	6	7	8	9	10	11	12	13	14
0000										7 36					19	15 35														
0100																	10 42		8 30	11 43	11 58	19 47	20 66	13 64	14 53	26 59	13 59	19 81	20 78	17 48
0200										6 27					18 48	15 41		12 43												
0300																			12 26	11 47	10 37	15 42	19 42	13 56	45 67	16 60	14 52	18 74	19 71	17 45
0400										7 24					17 59	17 40		9 46												
0500																			10 31	12 51	10 43	16 45	19 58	16 56	42 88	12 44	14 35	22 67	20 49	17 45
0600																17 64		9 42												
0700																			12 39	16 37	17	12 41	18 72	17 61	32 119	15 53	16 43	27 50	22 45	18 41
0800		18 69	13 32	12 21	13 25	9 22	14 38			11 21						22 86		19 59												
0900								18 48							25 85		4 46		6 55	7 47	12 51	11	13	15 61	12 50	11 44	15 45	31 55	23 62	
1000	10 62	13 95	11 16	10 20	15		8 30			8 24						29 63		21 65												
1100								14 32		56 21					19 65		5 47		5 41	4 52	7 40	9 42	8 38	9 37	8 37	9 39	13 52	25 54	16 82	
1200					13 34		7 24							12		6 30		13 45												
1300								20 39		4 24					11 51		7 36		6 36		5 41	10 45	6	13 35	6 24	8 29	10 51		15 68	
1400				10 27	33	29										8 28														
1500	8 63	11 56						40		4				9 31	10 55		7 27	10 59	45	6 45	7 33	7 45	5 35	16 52		9 46	17 51	15 59	13 42	
1600																4 34														
1700		47								4 24				41	10 57		8 32	9 41	7 41	5 92	5 42	6 48	5	18 66	7 27	7 45	16 55	16 79	15 44	
1800																														
1900															11 38	9 25	5 24	8 35	8 49	7 49	6 32	5 42	5 32	19 67	12 33	8 57	15 64	19 71	14 44	
2000																														
2100										9				17 52	8 46	12 61	5 26	9 40	9 38	8 58	8 42	6 34	24 40	16 71	27 65	12 55	118 65	25 80	14 41	
2200																														
2300																10 69	7 24	9 38	10 57	8 50	10 41	11 40	8 40	13 46	25 71	11 42	21 73	29 101		

Hour of day (CDT)

(*)This Table is taken from Rasmussen et al (WSU: 1977)

During the 1976 study, the MRI aircraft collected 72 hydrocarbon grab samples, which were also analyzed by WSU. The summary results are included in Appendix A.2. Detailed results are given in a separate MRI data volume.

3.2.4 Battelle Organic Vapors Measurements

Urban vapor-phase samples were collected by EPA over St. Louis during the 1975 field program, and submitted to Battelle Columbus Labs for analysis. A total of 9 airborne samples were collected at four sites on four days using chromosorb 102 chromatographic traps without the use of filters. Approximately 300 ℓ of gas per sample were collected over a period of about 20 minutes. The samples were analyzed for organic vapors by methane chemical ionization gas chromatography-mass spectroscopy. The work was reported by Mendenhall et al (Battelle: 1978). The report gives details of sample times and locations and results.

3.2.5 FSU Jensen Nelson Streakers

Time sequence streaker samplers, employing Nucleopore filters for aerosol collection, were deployed at a number of RAPS ground stations during the period 14-25 July 1975. The objective was to characterize the sources and transport of trace metals together with sulfates, organic matter, and other non-metallic constituents in urban aerosols. Particular emphasis was placed on relations between aerosol sulfur and trace metal constituents in the urban atmosphere.

Elemental analysis of 2-hourly samples was made possible by the high sensitivity of the proton induced x-ray emission (PIXE) technique. Computer resolution of the x-ray spectra for the elements S, Cl, K, Ca, Ti, V, Cr, Mn, Fe, Ni, Cu, Zn, Br, and Pb was carried out at a rate equal to the proton irradiation rate, five minutes or less for each time step analysis.

Trace element pollutants were distinguished from their natural components on the basis of particle size distributions obtained by the use of cascade impactors.

A report (FSU: Winchester and Nelson, 1979) describes the sampling and analysis techniques, as well as data interpretations concerning clues to the sources of trace metals in St. Louis urban aerosols, and in some cases, their transport downwind.

3.3 Tracer Studies

3.3.1 CalTech SF_6/CF_3BR Tracer Release and Sampling

Five full-scale atmospheric tracer field studies were conducted in St. Louis between August 8 and 15, 1975. The tracers used were SF_6 and CF_3Br. The objective of the tracer study was to obtain specific transport and dispersion data concerning emissions from low-level and elevated sources.

The experiment days were August 8, 9, 11, 12-13, and 15. SF_6 was released on each day for a period ranging from 4 to 6 hours, typically ending at 3:00 p.m., from one of three release sites - RAMS station 111, Webster College, or the 1000 foot KETC TV tower. CF_3Br was released from RAMS station 111 on all days except 8/12-13. Samples were collected at fixed sites (several of the RAMS stations), during automobile traverses, and from an airborne platform. Sequential samplers were used at the fixed sites. They collected hourly-averaged samples for 12 consecutive hours. In the automobile and airborne platforms, grab samples were collected in syringes. Several airborne samples were also integrated air samples over a distance of about a mile. During the five days, a total of 929 hourly samples were collected at the fixed sites, 2162 grab samples were collected in 50 automobile traverses, and 63 samples were collected in four airborne traverses.

Both tracers were analyzed using electron capture gas chromatography. Calibration of all the chromatographs was accomplished by means of a well-mixed exponential dilution system. The detection limits were 10^{-12} parts SF_6/part air at a signal-to-noise ratio of better than 3 to 1, and 10^{-9} parts CF_3Br/part air. The uncertainty of the test data was approximately ± 8%, overall.

The SF_6 was definitively observed in 70% of the automobile traveres, and in 2 of 4 airborne traverses. The corresponding numbers for CF_3Br were 6% and 0.

A report (CalTech: Lamb et al, 1975) of the study summarizes the measurements and chemical analysis techniques, and presents tabulations of the data and results of preliminary attempts at data interpretation.

3.3.2 Sandia da Vinci Balloon

The da Vinci balloon was a manned balloon, instrumented and operated by Sandia Labs under DOE sponsorship, with the objective of studying the long-range transport and transformation kinetics of air pollutants in a Lagrangian mode. A cooperative DOE/EPA mission took place on July 23-24, 1976 in which the balloon was launched into the St. Louis emissions during the morning of July 23. It was subsequently transported in the St. Louis emissions throughout the day out to Indiana, before the balloon was voluntarily diverted out of its Lagrangian track very early on July 24. The balloon finally landed in Kentucky in the morning.

The balloon served as a tracer or marker of a given St. Louis air parcel for the MISTT mission, in which in-situ aircraft measurements were made within this marked release. The transport of the balloon took place within a Gulf airmass in its southwesterly flow on the back side of an anticyclone. The background air was fairly clean.

The balloon itself, when fully inflated with helium, had a nominal volume of 186,000 ft^3. A gondola was suspended from it by a 70-foot long nylon cord. The balloon was of the zero-pressure type, i.e. venting excess helium to prevent pressure buildup within. It did not, therefore, maintain constant altitude. Altitude control was achieved by valving and ballasting. The gondola housed the crew of four and the payload of instrumentation. The on-board meteorological instrumentation monitored temperature, pressure, humidity, relative air motion and atmopsheric diffusion; the continuous air quality measurements included SO_2, O_3, B_{scat} and CNC; grab samples were collected for subsequent analysis of CO, hydrocarbons, halocarbons, NO_x and ozone; integrated filter-pack samples were collected and analyzed for SO_2 and aerosol sulfate; aerosol samples were also collected for elemental composition analyses by a variety of techniques including XRF, PIXE and scanning electron microscopy; aerosol size distribution analysis was facilitated by the use of a cascade impactor sampler. In all, many organizations supplied the instrumentation and/or performed the chemical analyses of collected samples. The Final Report of Project da Vinci (Sandia: Zak, 1981) provides much more detailed descriptions of the balloon hardware, measurements, and results of data analyses. The da Vinci data are not archived in the MISTT data base.

3.4 Surface Lidar Measurements

3.4.1 SRI Surface Lidar

The SRI mobile Mark IX lidar system was used in a mobile van during MISTT 1976 to derive information about the particulate density distribution in, and physical behavior of, the Labadie plume, particularly at night, at distances up to 130 km downwind from the power plant. The lidar technique used laser energy in a radar configuration for observation of atmospheric aerosol distribution. State-of-the-art instrumentation techniques - particularly digital data processing and real-time display - were used in this study.

The surface lidar was used on six different days during the period 14-23 July 1976 to investigate the behavior of the Labadie plume. The lidar was operated after dark in four of the six missions. The lidar operation was in a mobile mode on three occasions and in a stationary mode in the other missions. In the mobile mode, the lidar van traversed under the plume, firing the laser vertically up and receiving the vertical back-scatter from the different layers above. In the stationary mode, the laser was fired while making angular scans in the vertical plane in the direction of the plume.

No data of the lidar measurements are available. However, a publication (SRI: Uthe and Wilson, 1979) describes the lidar system, the measurement missions, and gives a summary and interpretation of the observations.

3.5 Meteorological Measurements

MISTT relied on RAPS for substantial meteorological support. However, supplementary pibal support specific to MISTT missions, and a collaborative effort with DOE to investigate PBL behavior and to provide micrometeorological surface layer measurements, were two meteorological measurement tasks commissioned by EPA as part of MISTT. Both efforts were part of the 1975 and 1976 programs.

3.5.1 Rockwell Mobile Pibals

The primary mission of MISTT was to study the dynamics and kinetics of plume processes, i.e. rate processes were of principal concern. In many daily missions, a given plume (or given plumes) were sampled at discrete downwind distances from the source(s). The accurate determination of plume ages at these sampled distances was of major importance to the main objectives of MISTT. Consequently, special emphasis was given in MISTT to characterize the prevailing flow field well. The upper air soundings of RAPS provided a good Eulerian characterization of the flow field in the vicinity of the sources. Rockwell International was assigned the task of measuring the PBL mean flow along the trajectory of the sampled plume, more or less in co-ordination with the primary sampling aircraft missions.

Rockwell deployed up to three mobile single-theodolite pibal teams in most missions to make pibal launches and measurements, at half-hour intervals, at variable locations. In practice, a two-way feedback loop existed between OHQ and the pibal teams during each mission. Appropriately placed and timed pibal measurements indicated to OHQ, in near-real time, the Lagrangian track of a designated plume parcel; OHQ, in turn, updated the next appropriate placement of the mobile pibals, and the new sampling locations of the aircraft.

During each mission, an attempt was made to move the three pibal teams in a staggered manner such that one or two teams were providing current measurements in the general vicinity of the sampling location as the others were being relocated to farther downwind locations. Tables 12 and 13 summarize the hourly pibal launches during the two field studies. In all, 372 mobile pibal measurements were made in the missions in 1975 (average 23 per mission), and 602 measurements were made in 17 missions in 1976 (average 35 per mission).

In 1975, only 30 gram balloons were used, day or night, and were inflated to a lift of 139 grams to enable assumption of the standard ascent rate. Night-time releases had lights attached. Elevation and azimuth angles were observed and recorded at 30s intervals for a maximum duration of 10 minutes. The data were computerized, processed, and quality-checked by Rockwell.

In 1976, 10 and 30 gram balloons were used. During daylight hours, 10 gram balloons were inflated to a lift of 45 grams, and at night, 30 gram balloons with attached lights were inflated to a lift of 139 grams. Standard ascent rates were assumed in each case. The raw data (elevation/azimuth angles) on hard copy forms were delivered to the Washington University data center following each mission. There, they were entered into the computer and processed into wind speed/direction. The processed data were quality checked by a meteorologist at MRI after completion of the field program. The necessary corrections were communicated back to WU, where the corrections were incorporated into the pibal data files.

TABLE 12

MISTT 1975

HOURLY SUMMARY OF MOBILE PIBAL DATA (*)

Date	0000 - 0059	0100 - 0159	0200 - 0259	0300 - 0359	0400 - 0459	0500 - 0559	0600 - 0659	0700 - 0759	0800 - 0859	0900 - 0959	1000 - 1059	1100 - 1159	1200 - 1259	1300 - 1359	1400 - 1459	1500 - 1559	1600 - 1659	1700 - 1759	1800 - 1859	1900 - 1959	2000 - 2059	2100 - 2159	2200 - 2259	2300 - 2359	Observation Period	Total
7/17							3	6	6	2	0	1	0	6	6	3	2	1							1	36
7/18							2	4	6	1	2	4	6	2	2	0	4	3							2	36
7/19							1	1	2	4	3	2	2	2	2										3	19
7/20																										
7/21							2	4	4	4	0	1	5												4	20
7/22						4	3	1	5	1	0	3	1	1	3										5	22
7/23																										
7/24																			1	6	3	0	0	2	6	
7/25	5	3	1	0	0	1																			6	22
7/26									5	4	4	1	1	2	2										7	19
7/27																										
7/28								1	2	2	2	4	3	0	2	4	2								8	22
7/29													1	0	0	3	5	3	0	3	5	3	0	4	9	
7/30	5	3	0	4	3	2	5	6	4	3															9	62
7/31																										
8/1																										
8/2																										
8/3																										
8/4							4	6	2	0	2	2	2	2	2	0	0	2							10	24
8/5									1	2	2	2	0	2	0	1									11	10
8/6																	2	0	2						12	4
8/7													1	1	2	2	2	0	1	0	1	1	1	1	13	13
8/8																				2	2	0	1	2	14	
8/9	2	1	0	1	2																				14	13
8/10																										
8/11								4	2	3	4	2	2	4	2	3	2	3	3	6	3				15	43
8/12																										
8/13							2	2	1	1	1														16	7
																									All	372

(*) TAKEN FROM ROCKWELL: BRYANT 1975

TABLE 13

MISTT 1976

HOURLY SUMMARY OF MOBILE PIBAL DATA (*)

DATE	0000 - 0059 CST	0100 - 0159 CST	0200 - 0259 CST	0300 - 0359 CST	0400 - 0459 CST	0500 - 0559 CST	0600 - 0659 CST	0700 - 0759 CST	0800 - 0859 CST	0900 - 0959 CST	1000 - 1059 CST	1100 - 1159 CST	1200 - 1259 CST	1300 - 1359 CST	1400 - 1459 CST	1500 - 1559 CST	1600 - 1659 CST	1700 - 1759 CST	1800 - 1859 CST	1900 - 1959 CST	2000 - 2059 CST	2100 - 2159 CST	2200 - 2259 CST	2300 - 2359 CST	OBSERVATION PERIOD	Total
6/29												3	1												1	4
6/30									3	1															2	4
7/1							1	5	6	5	6	5	5	1											3	34
7/2							1	2	5	6	6	3	3	2	2	3	3	1							4	37
7/5											4	6	6	3	4	6	6	6	6	4	2	3	5	5	5	
7/6	4	3	4	5																						82
7/7								3	2	2	2	2	2	2	2	2	2	1	2	2	2	2			6	30
7/9							6	6	5	3	6	4	3	2	5	6	3	2	4	5	3	2	1	2	7	
7/10	4																									72
7/12														1	5	2	3	2							8	13
7/14					3	4	2	7	4	4	6	5	5	5	6										9	51
7/15							2	2	4	5	4	4	4	4	2										10	31
7/18									3	4	1	1		2	3	4	2	3	3	1	2	4	4	5	11	
7/19	1																									43
7/20									1	5	3	2	2	4	5	6	3	3	4	3	3	4	3	3	12	54
7/22										3	6	2	5	5	6	2									13	29
7/23								3	2	1	2	2	3	2	2	2	3	3	3	2					14	
7/24	1		2	3	2	2	1	2																		43
7/26					3	4	4	2																	15	13
7/28				1	3	2	2	4	4	3	4	4													16	27
7/30				4	4	4	4	4	2	2	2	3	1	4	1										17	35
																										602

(*) TAKEN FROM ROCKWELL: WALDRON, 1976

The mobile pibal data are archived in the formal MISTT data base. Rockwell has submitted to EPA a report on each task (Rockwell: Bryant, 1975; Waldron, 1976). The report describes the experimental equipment and procedures, and also contains annotated maps showing all the pibal launch sites.

3.5.2 ANL Micrometeorological and PBL Measurements

Argonne National Laboratory conducted two complimentary experimental studies in the summers of 1975 and 1976, under the joint sponsorship of DOE and EPA, to investigate the evolving structure of the PBL under morning and evening transition conditions. The 1975 study (7/21-8/13/75) investigated the early morning breakup of the nocturnal stable layer and the rapid growth of the mixed layer before noon. The 1976 study (7/16-7/30/76) examined the decline of the mixed layer through the late afternoon and evening, and the formation and intensification of the ground-based inversion before midnight. These Argonne studies are called The Sangamon Field Experiments.

The dynamics of the PBL are driven by surface heat and momentum fluxes. The study was therefore aimed, on the one hand, at monitoring the dynamics of the PBL top (i.e. mixing layer structure) and, on the other hand, at quantifying the surface fluxes and their variabilities. To characterize the structure and upper boundary condition of the PBL, vertical profiles of temperature, humidity and wind field were measured, as well as acoustic soundings were made. The acoustic measurement monitors the backscatter of acoustic waves emitted from the ground into the PBL. The signal is strong in the daytime mixing layer, and the top of this layer appears clearly delineated from the relatively quiescent layers above. The acoustic sounder thus provides a convincing and accurate picture of PBL mixing and top, and continuous soundings provide a good picture of PBL dynamics.

To quantify the lower boundary conditions, micrometeorological measurements required to yield the heat and momentum fluxes were made. EPA's support was principally focused on this part. A particular effort was made to develop an average view of the lower boundary conditions which could be taken to represent the entire mesoscale surface surrounding the observation site. The main observation site was near Auburn, Illinois, about 120 km NNE of St. Louis, and about 60-70 km directly due east of Glasgow, Illinois (the site of the EPA trailer in 1975). These sites are marked in the map of Fig. 1. The terrain in this region, which is representative of the terrain over which the St. Louis plumes are typically transported under westerly and southerly flows, is quite flat. There are, however, some non-uniformities of vegetation. Surface flux measurements were made on maize and soybean fields, and the results were averaged to yield results more representative of the general area surrounding the observation site.

Micrometeorological measurements included the following:

- Total and net solar radiation at ground level using radiometers (TOTRAD, R_n)
- Momentum flux using eddy-flux equipment, and based on eddy-correlation method; result presented as friction velocity (U_*)
- Sensible heat flux (H) using eddy-flux equipment, and based on eddy-correlation method;
- Surface (actually at 1.3 m) wind spped and direction, and surface temperature and humidity using microbarometers, infrared thermometers, and hygrothermometers.

All of the above micrometeorological data were continuously recorded, and subsequently averaged over half-hour intervals. The MISTT data base includes these half-hourly averages.

A detailed report (ANL: Hicks et al, 1981) of the Sangamon Field Experiments describes the measurements and results, and also gives tabulations of the half-hourly micrometeorological data, the vertical profiles of wind speed/direction and temperature, and pictorial graphs of the acoustic sounding returns.

3.6 Smog Chamber Measurements

3.6.1 Battelle Smog Chamber Studies

Under MISTT sponsorship, Battelle Columbus Labs carried out laboratory as well as outdoor smog chamber experiments.

Laboratory experiments were conducted in Battelle's 17.3 m^3 smog chamber. Direct irradiation through a Teflon window was provided by 95 fluorescent blacklamps (photon flux distributed unimodally in u.v. region with peak intensity at 370 nm) and 15 sunlamps (peak intensity at 310 nm). The lamps yield a NO_2 photo-dissociation rate of 0.27 min^{-1}. Background air for the chamber was passed through a purification system which included permanganate pellets, a charcoal filter system and an absolute filter. The air was humidified to R.H. in the 40-50% range at 30°C. HONO was added to the chamber to provide a source of OH, and then the combined reactivity of the air correspnded theoretically to the reactivity of 0.046 ppm butane. The gas phase chemistry of the mixture was monitored with conventional instrumentation. Detailed hydrocarbon analyses were obtained hourly with two FID gas chromatographs.

Outdoor smog chamber experiments under natural irradiation were also conducted in July 1976 in St. Louis at RAMS stations 106 and 103. A 13.5 m^3 Teflon chamber was used to confine early morning air. The RAMS data provided characterization of this air parcel. During the course of the experiments, direct measurements of the chamber atmosphere were made for SO_2, NO, NO_x, O_3, aerosol size distributions, and sulfate aerosol by filtering.

The data were analyzed, in particular, to assess the dependence of SO_2 oxidation on percursor effects. Details of the measurements and results are given in two Battelle reports to EPA (BATTELLE: Miller, 1977a, 1977b) and in a journal publication (BATTELLE: Miller, 1978).

4. PERTINENT RAPS MEASUREMENTS AND EMISSIONS DATA

4.1 RAPS Measurements

The St. Louis Regional Air Pollution Study (RAPS) was a major EPA-sponsored urban air monitoring program based in St. Louis over the period 1972-1977. The first two years of the study were devoted to planning and preparations. The major field measurements program began in mid-1974 and concluded in June 1977.

The principal objective of RAPS was to create a comprehensive, accurate, and readily retrievable data base for all criteria pollutants (SO_2, NO_x, CO, oxidants, hydrocarbons, and particulates) and selected non-criteria pollutants to use in evaluating air quality simulation models (AQSM) applicable over scales up to those of an air quality control region (AQCR).

The general design of the RAPS field measurement program consisted of continuous ground level measurements from a 25-station telemetering Regional Air Monitoring System (RAMS) to provide an extensive data base for evaluating and developing AQSMs; measurements from instrumented helicopters (comparable to MISTT primary sampling aircraft) to complement the surface measurements by aerometric measurements aloft; an Upper Air Sounding Network (UASN) for information on meteorological structure aloft; emissions data obtained through an extensive emissions inventory effort; and expeditionary studies to describe particular atmospheric processes to be incorporated as model modules or sub-models.

The Air Monitoring Center of Rockwell International, as prime contractor, was charged with establishment and operation of the routine RAPS air quality and meteorological measurement networks and the data handling facility. The RAPS helicopter program was conducted by EPA's Environmental Monitoring and Support Laboratory (EPA-EMSL) based in Las Vegas. Additionally, Rockwell supported the RAPS research program by specialized atmospheric sampling, sample analysis, data processing, and data analysis through approximately 90 task orders completed on an as-needed basis. Additional RAPS participants included numerous universities, private research organizations, and other governmental agencies. Their activities were comparable to those of participants of the MISTT program. In the following sections, the essential features of RAMS, UASN, the helicopter program, and the RAPS emissions inventories are described very briefly, mainly to remind potential users of the MISTT data base of the availability of this rich related data base. The material in this chapter is taken largely out of two EPA reports (RAPS: Strothman and Schiermier, 1979; RAPS: Mage et al, 1979). The first of these documents is a comprehensive summary of the entire RAPS effort, and the latter is a report describing the helicopter program. The first report also describes the RAPS Data Bank. The data of all of the RAPS components described here are available on magnetic tapes from EPA.

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4.1.1 RAMS Surface Network

RAMS consisted of 25 remotely operated, automated ground monitoring stations controlled and polled via telemetry by a central data acquisition system at the RAPS Headquarters. The locations of these stations, shown in Figure 4, were arranged in approximate concentric circles with average radii from the central urban stations of 5, 11, 20, and 44 km. Station elevations were fairly uniform, averaging 154 ± 23 m MSL. The station density was highest near the center of the network, and diminished at each outer circle. The four outermost rural sites, spaced at approximately 90° azimuth, were situated so as to provide background measurements regardless of wind direction.

Each RAMS station consisted of a shelter, meteorological tower, fence, sensors, and support equipment. The met towers were erected on the northern side of each station. Seventeen stations had 30 m towers, and the other eight had 10 m towers.

There were three major categories of instrumentation within each RAMS station: pollutant analyzers and collectors, meteorological sensors, and test/control systems. The instrumentation and measurements of the first two categories are summarized in Table 14 and 15. The distribution of these instruments at the RAMS stations is shown in Table 16. For details concerning instrument calibrations, QA and performance, readers are referred to the report of Strothman and Schiermeier. The RAMS continuous data are normally available from the RAPS Data Manager in hourly averages on magnetic tapes.

4.1.2 Upper Air Sounding Network (UASN)

The RAMS network provided a relatively dense data base of surface winds, temperature and relative humidity. The objective of the UASN was to provide upper air data for these parameters using balloons and airborne instrument packages. The permanent network consisting of four stationary sites (stations 141, 142, 143, 144 - see Fig. 5) operated between November 1974 and May 1977. During July-August 1974, a temporary network consisting of sites 201 and 202 was in operation. The permanent sites were located in downtown St. Louis (141), Times Beach, Missouri (142), south of Belleville, Illinois (143), and east of Alton, Illinois (144). Table 17 summarizes the observations and measurements at the permanent stations.

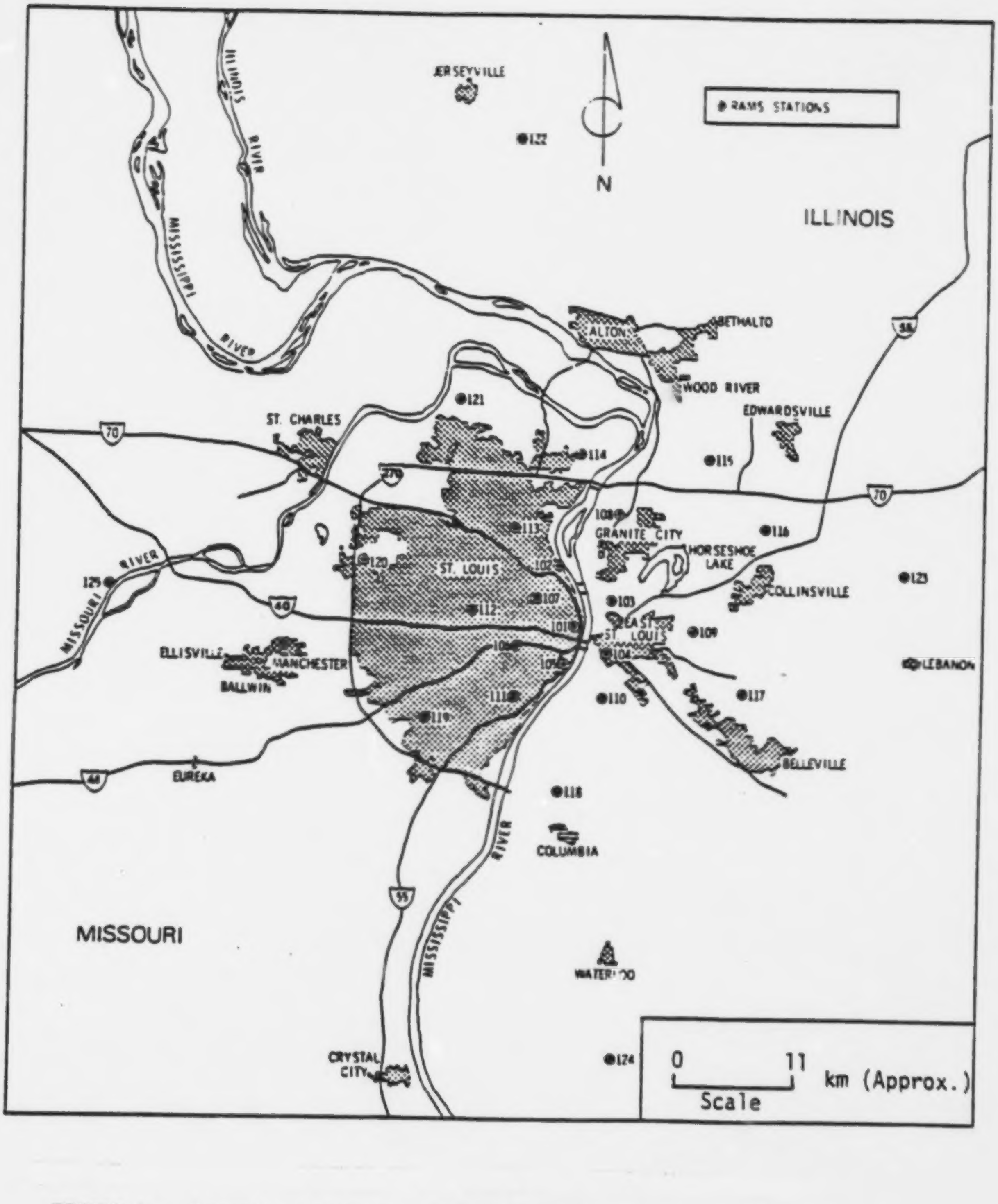

FIGURE 4. Location of the Regional Air Monitoring System (RAMS) Stations

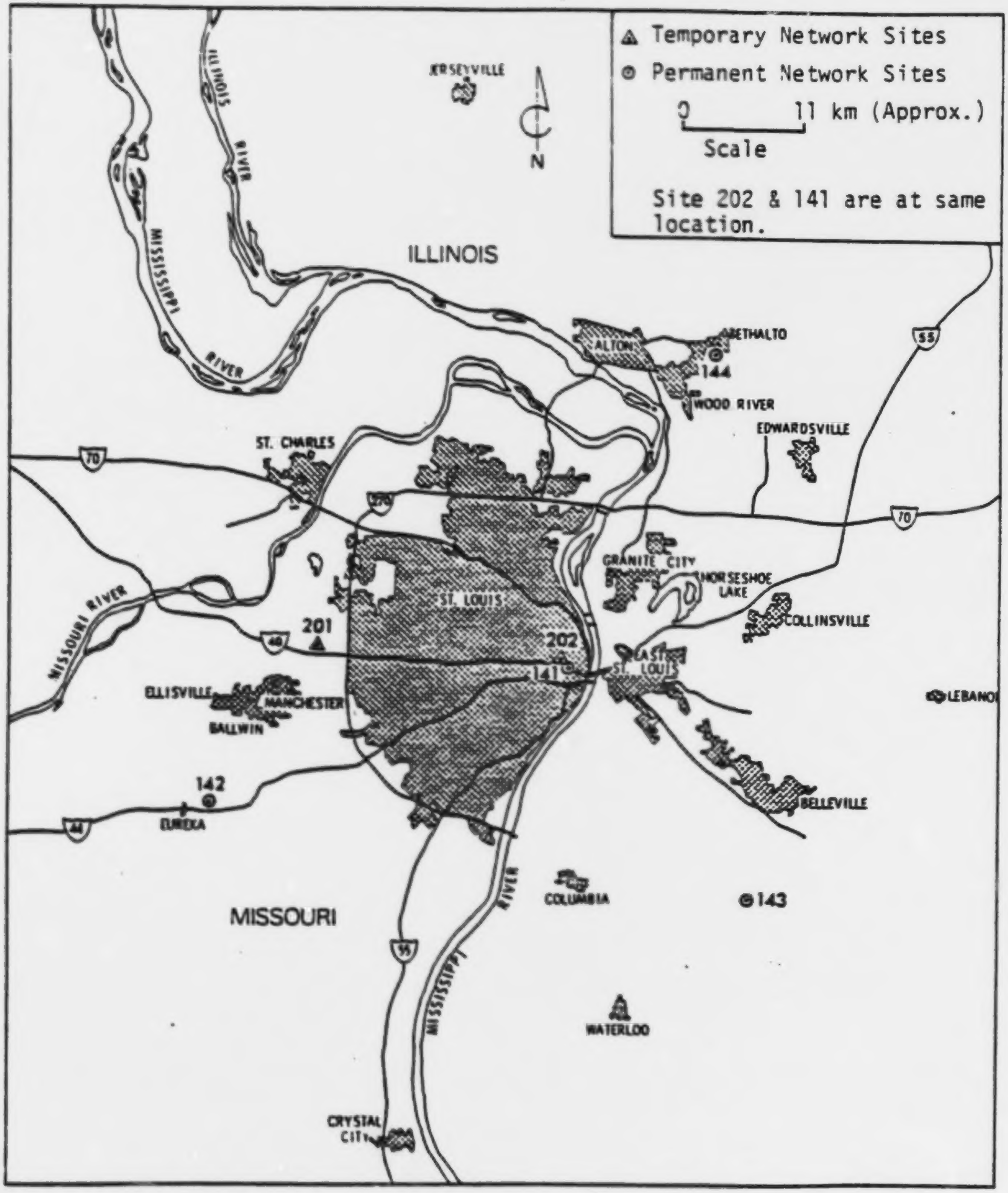

FIGURE 5. Locations of Upper Air Sounding Network Sites

TABLE 14.

ROUTINE POLLUTANT MEASUREMENTS AT RAMS NETWORK STATIONS

PARAMETER	INSTRUMENT/METHOD USED	EFFECTIVE MEASUREMENT HEIGHT	RANGE	MINIMUM DETECTION LIMIT
Ozone	Moniter Labs 8410AA (chemiluminescent analyzer)	4 m	0 - 500 ppb	5 ppb
NO/NO$_x$ *	Moniter Labs 8440 (chemiluminescent analyzer)	4 m	0 - 500 ppb	5 ppb
Hydrocarbons, and CO *	Beckman 6800 gas chromatograph	4 m	0 - 25 ppm 0 - 50 ppm	
SO$_2$ and Total Sulfur *	Tracer Inc. 270HA (chemiluminescent analyzer)	4 m	0 - 1 ppm	5 ppb
Total Sulfur *	Meloy SA-185 (chemiluminescent analyzer)	4 m	0 - 1 ppm	5 ppb
Light scattering coefficient	MRI 1561 integrating nephelometer	5 m	0.1 - 10 ($10^{-4}m^{-1}$)	
Gas Bags	Xonics bag sampler using 100 1 Teflon and Tedler bags	4 m	Flow rate, 0 - 1200 cc/min	
Total Suspended Particulates (TSP)	Sierra 305 high-volume sampler with 20x25 cm glass fiber filter. Sierra 320 blow controller	4 m	20 liters per second flow rate	
TSP (fractionated)	LBL automatic dichotomous air sampler with cutoff at 2μm. Samples collected on cellulose acetate filters		20 liters per second flow rate	

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*EPA requirements for the five gas analyzers included allowable zero drift of 2% per day and allowable span drift of 5% per day.

TABLE 15

ROUTINE METEOROLOGICAL MEASUREMENTS AT RAMS NETWORK STATIONS

PARAMETER	INSTRUMENT/METHOD USED	EFFECTIVE MEASUREMENT HEIGHT	RANGE	ACCURACY
Wind speed	MRI 1022S 3-cup anemometer	10 or 30 m (tower height)	0.22 to 22.35 m/s	Greater of ±.067 m/s and 1%
Wind Direction	MRI 1022D wind vane	10 or 30 m	0 to 540°	0.1% resolution
Temperature	MRI 840-1 dual thermistor and resistor network	5 m	-20 to +50°C	±.05°C
Dew Point	EG&G International 880 optically sensed, thermoelectrically cooled condensation dew point hygrometer	2 m	-40 to +50°C	Accuracy 1°C Resolution 0.25°C
Temperature Gradient	MRI 840-1/840-2 thermistor and resistor networks	5 and 30 m	-5 to +5°C	±1°C
Barometric Pressure	MRI 751/YSI 2014 transducer system	2 m	27.0 to 31.5"Hg (947 - 1080 mb)	Resolution 0.2% of full scale
Solar Radiation	Eppley Lab precision spectral pyranometer, normal incidence pyreheliometer, precision infra-red radiometer (pyrgeometer)	5 m	0 - 4 cal cm^{-2} min^{-1}	
Turbulence	R.M. Young 27002 Gill UVW Anemometer	30 m	0.22 - 22 m/3	

TABLE 16. RAMS REMOTE STATIONS INSTRUMENT DISTRIBUTION

		101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125
O_3 - Monitor Labs 8410		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
NO - NO_X Monitor Labs 8440		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
CO - CH_4 - THC Beckman 6800		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
TS - SO_2 -H_2S Tracor 270HA		X		X	X	X	X		X					X	X	X	X				X	X	X			
TS - Meloy SA 185			X					X		X	X	X	X					X	X	X				X	X	X
Visibility -MRI 1561		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Wind Speed - MRI 1022 S		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Wind Direction -MRI 1022 D		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Temperature - MRI 840-1		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Dew Point - Cambridge 880		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Temp. Gradient - MRI 840-2		X	X		X	X	X	X		X		X	X	X									X	X		
Barometer - MRI 751/YSI 2014		X								X			X										X	X	X	X
Solar Radiation (Eppley)	Pyranometer			X	X				X						X				X				X			
	Pyrheliometer			X											X				X				X			
	Pyrgeometer			X											X				X				X			
Turbulence - R. M. Young 27002						X		X		X		X		X												
Gas Bags - Xonics		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Hi - Vol, Sierra 305				X		X	X		X				X			X			X		X		X		X	
LBL Dichotomous Sampler				X		X	X		X				X			X			X		X		X		X	
10 Meter Tower									X		X				X	X	X	X	X			X				
30 Meter Tower		X	X	X	X	X	X	X		X		X	X	X						X	X		X	X	X	X

TABLE 17

UASN MEASUREMENTS AND INSTRUMENTATION

PARAMETER MEASURED	INSTRUMENT/METHOD USED
Cloud type	Visually determined
Total Opaque Sky Cover	Visually determined and recorded as tenths of sky coverage
Surface Pressure	3 Wallace and Tiernam aneroid barometers 1 Bendix aneroid barometer, and 1 Weather Measure B211 microbarograph
Surface Ambient Temperature, Dew Point and R.H.	Sling psychrometer with two ventilated mercury thermometers dry and wet bulb temperature.
Surface Wind Speed and Direction	141, 142: Taylor Scientific Windscope No. 3120 using a 3-cup anemormeter and wind vane. 8 point wind direction resolution referenced to true north. 143,144: Dwyer hand-held wind meter for speed, wind direction from first half minute of balloon ascent.
Wind Speed and Direction Aloft	Release of 10 or 30 gram pilot balloon (pibal) tracked by a single theodolite (Warren-Knight) to 1344 m or 1890 m, respectively.
Temperature, Relative Humidity, Barometric Pressure, Wind Speed/ Direction Aloft	Two types of radiosondes were employed: VIZ 403 MHz Model No. 1395 (standard thermistor, hygristor and baroswitch) tracked by a Warren-Knight single theodolite; VIZ 1680 MHz Model No. 1392 (standard thermistor, hygristor and baroswitch) tracked with a GMD-1A Rawin set. T, RH, and P recorded by Bendix TMQ-5 GMD receivers.

The UASN measurements included upper air pibal and radiosonde measurements, as well as surface measurements. The pibals (10 or 30 gram) were released every hour, with angular readings taken every 30 s for a 10 min. duration. The radiosondes were released at 6 hour intervals, and were carried aloft by a 100-gram balloon at a slow ascent rate, reaching an altitude of approximately 3 km (700 mb) in 20 minutes. Surface measurements coincided with the radiosonde observations.

Upper air data collections were normally taken for 5 days a week (Monday-Friday) except during intensive periods when operation was daily. The intensive periods included July 13 - August 15, 1975 and July 12 to August 13, 1976. The UASN processed data of the pibals and radiosondes are available on magnetic tapes from the RAPS Manager.

4.1.3 RAPS Helicopter Measurements

Complementing the extensive surface-based aerometric and upper air meteorological data bases of RAMS and UASN, an aerial monitoring system consisting of three instrumented Sikorsky 58 helicopters provided a data base of aerometric measurements aloft. The helicopters operated during selected periods to coincide with data gathering by the various research investigators. Preselected flight paths were chosen so that, for any given wind direction, aerometric soundings would be made over six to eight particular RAMS stations in a roughly elliptical flight pattern. The paths were often designed to provide data upwind of the urban area as well as downwind of the principal source aggregations. Soundings consisted of spirals from above the existing stable layer downward to about 60 m above ground.

Two air sampling systems were available, and were installed in two of the helicopters. The third helicopter served as backup. The helicopters and air sampling systems were designed to facilitate relatively easy deployment of the backup helicopter, when necessary. The helicopter instrumentation package is summarized in Table 18. The reader is referred to the RAPS Helicopter Report (RAPS: Mage et al, 1979) for details concerning instrumentation, quality assurance, data processing, etc., as well as measurement strategy and flight paths.

RAPS helicopter measurement periods included the following periods relating to MISTT summer intensives:

1975: July 14 - Augsut 15
1976: July 12 - August 13

Data are available as unaveraged, engineering units on magnetic tapes from the RAPS Data Manager.

4.2 Emissions Data

4.2.1 RAPS Emissions Inventories

A major division of the RAPS field measurement program consisted of the emission inventory effort. The objective of this effort was to compile a sufficiently detailed St. Louis emissions data base, based as

TABLE 18

RAPS HELICOPTER INSTRUMENTATION

PARAMETER MEASURED	INSTRUMENT/METHOD USED
SO_2	Meloy SA-160 (FPD). Sensitivity 5 ppb
NO/NO_x	Monitor Labs 8440 chemiluminescent analyzer. Sensitivity 1 ppb
Ozone	REM 612 chemiluminescent analyzer Sensitivity 1 ppb
CO	Beckman/Andres 7000 non-dispensive infrared analyzer. Sensitivity 0.1 ppm.
Total Hydrocarbons and Methane	Mine Safety Appliances Company (MSA) 11-2 flame ionization detector. Sensitivity 0.1 ppm.
Light Scattering Coefficient	MRI 1550 integrating nephelometer equipped with a preheater. Range 0.1 to 100 ($x10^{-4} m^{-1}$).
Particle Size Distribution	Royco 220 aerosol-particle monitor. Coupled with a multi-channel analyzer. Resolution into 8 size ranges above 0.5/μm.
Temperature and Dew Point	EG&G Vapormate II using a CS137 thermometer-hygrometer probe.
Pressure/Altitude	Computer Instruments Corp. (CIC) 8000 electric altimeter.
TSP	37 mm filter sampler with Gelman carbon vane pump and Magnehelic flow meter.
Gas Bags (561)	For hydrocarbon analysis.
Avionics (VOR/DME/Air Speed/Heading)	Bendix RVA-33A VOR Receiver Collins DME-40 Tranceiver DDC 4700 for Heading CIC 7100 Differential Pressure Transducer for Airspeed

much as possible on measured values commensurate in detail and accuracy with those of RAMS, for use as input in the analyses of special field experiments as well as the overall urban air pollution models. Emissions data were collected for a base period of two years (1975 and 1976) for the St. Louis Air Quality Control Region (AQCR 70). The following inventories were collected:

A. Point Sources

1. Criteria pollutants - TSP, SO_x, NO_x, THC, CO
2. Hydrocarbon breakdown
3. Non-criteria pollutants
4. Heat
5. SO_3
6. Particulate size distribution

B. Area Sources

1. Criteria pollutants - TSP, SO_x, NO_x, THC, CO
2. Hydrocarbon breakdown
3. Heat

The RAPS emission inventory utilized the NEDS information on the annual emission of SO_x, CO, NO_x, HC, and particulates as a starting point and general guideline. Emission sources were classified according to mobile or stationary, point or area. Further subdivisions were considered as necessary. Some of the major subdivisions are outlined below:

- Stationary point sources
- Residential and commercial area source
- Line sources
- Line and area source motor vehicles
- Airports
- Railroads
- River towboats
- Off-highway mobile sources
- Fugitive dust

Specific methodology for inventorying the emissions for each subdivision was laid out. These are described in specific RAPS reports.

Special attention was given to detail in the hydrocarbon inventory to permit breakdown into broad categories of types of hydrocarbon sources and emissions. The special requirements of the RAPS program were: the inclusion of smaller point sources (than in NEDS); a hydrocarbon breakdown corresponding to SCC (Source Classification Code) numbers of NEDS; and hourly emission estimates. No measurement data were collected in this effort.

An extensive program of quality assurance/assessment of the emissions data was also executed. Q.A. of the point, line and area source emission inventories were determined independently of one another. The inventory data were reviewed and methodology subsystems checked. The reviews included, for example, individual verification of all stack parameters (e.g. UTM co-ordinates and zone, stack height, boiler capacity, stack diameter, gas exit rate and temperature, etc.). For ten selected sources, process data for a specific day were checked, and hourly emissions were hand calculated and compared with computer data. Hourly, weekday/weekend and seasonal variations were verified, and annual retrieval programs were run. Descriptions of input data checks, all test runs, hand calculations, comparisons and documentation of methodology modifications were submitted on status sheets to the EPA Task Co-ordinators. These status sheets were accepted in lieu of a formal final report.

RAPS point source data base contains hourly data for criteria pollutants for the St. Louis AQCR (70) for all of 1975 and 1976. The emissions data of a number of non-criteria pollutants are based on estimates from process data using emissions factors. Process data and emissions factors data for all stationary industrial sources in AQCR 70 are resident in the RAPS data base. Software for computing non-criteria pollutant emissions from these is also in the data base.

RAPS area source emissions are presented in the context of the RAPS emissions grid system, consisting of 1989 grid squares. Grid squares were determined based on a reasonably uniform distribution of the latest available population counts from square to square, as long as the minimum grid square size was one square kilometer. The RAPS gridding system is based on UTM co-ordinates. The squares are smallest (1 square km) in the core region of the AQCR where the population is most dense, and become larger farther out as the population density decreases. The largest grid square is 100 km^2. Figure 2 shows the SO_x, NO_x, HC emissions for the region based on this grid system.

RAPS stationary area sources are defined as those which are not major stationary point sources. The latter include all sources which individually contribute more than approximately 0.1% of the total emissions of a given pollutant in the AQCR. The methodology for assignment of sources to gridded squares is described in the appropriate RAPS reports. The area source gridded emissions data for 1975 and 1976 are available in hourly estimates on magnetic tapes. Hydrocarbons are broken down into four classes: olefins, aromatics, paraffins and aldehydes.

A number of RAPS reports describe the approach, methodology, data collection procedures, quality assurance, and other aspects pertinent to the development of the emissions inventories. For those interested in further details, we recommend first consulting the report of Strothman and Schiermeier (RAPS: 1979). If more detail is desired, the reader may obtain and refer to the five volume Emission Inventory Handbook (RAPS: Littman, 1977), which contains a total of at least 25 reports (in a looseleaf format) separated into such separate sections as Scope of RAPS Inventory, Point Source Emissions, Area Source Emissions, RAPS Emissions Inventory Data Handling System, and Evaluation and Validation of RAPS Emission Models.

The Emissions Inventory data tapes are available from the RAPS Data Manager.

4.2.2 UE Power Plant Operations Data

For the month of July 1976, the data of the actual hourly electrical power output of each boiler unit at all the power stations operated in the St. Louis area by the Union Electric Company are available in hard copy form in the central MISTT data bank. The data for Labadie and Portage des Sioux are a subset of this data set. In addition, for five particular mission days of 1976, viz July 5, 9, 14, 18 and 30, additional information necessary to estimate stack sulfur and heat fluxes are available for Labadie in the form illustrated in Table 19. These five data sheets are included in the appropriate daily summaries in Appendix A.2.

TABLE 19

POWER PLANT DATA SHEET

Power Plant: Labadie, UE

Date: 7/9/76

Hour (CDT)	MW generated/boiler				
	#1	#2	#3	#4	Total
0700-0800	560	542	554	547	2203
0800-0900	560	548	577	567	2252
0900-1000	560	557	577	564	2258
1000-1100	560	558	578	565	2261
1100-1200	560	556	578	558	2252
1200-1300	557	555	569	559	2240
1300-1400	512	552	501	557	2122
1400-1500	484	550	570	545	2149
1500-1600	489	546	580	538	2153
1600-1700	520	550	582	534	2186
1700-1800	549	550	579	527	2205
1800-1900	535	550	563	494	2142

Exit Conditions
At: 1200 CDT

Temperature(°F)	
#1	336
#2	335
#3	340
#4	335

Velocity(ft/sec)	
#1	89
#2	84
#3	93
#4	86

MW	Btu/KwHr
200	10390
300	9460
400	9000
500	8845
600	8880

Fuel: Coal

Average(*) %S = 3.17
Btu/lb = 11042

(*)Monthly average.

5. MISTT REPORTS AND PUBLICATIONS

The following list of MISTT-related reports and publications is not exhaustive. It includes selected works which are probably adequate to provide interested individuals sufficient basic information concerning each of the measurement platforms, and also leads into other documents providing further detail. The written products are presented by participating organizations to which the principal author belonged at the time of the report. Reports, internal to the organization or published, and papers presented at technical meetings are listed first, followed by journal publications.

5.1 EPA-ESRL

Wilson,W.E., R.J. Charlson, R.B. Husar, K.T. Whitby and D. Blumenthal (1977). Sulfates in the Atmosphere - A Progress Report on Project MISTT. EPA-600/7-77-021 (March 1977).

English, T.D., W.E. Wilson, K.T. Whitby, R.B. Husar, R.J. Charlson, D. Blumenthal (1979). Atmospheric Sulfates and Project MISTT. Unpublished Report.

Wilson, W.E., R.B. Husar, K.T. Whitby, D.B. Kittelson, and W.H. White (1976). Chemical Reactions in Power Plant Plumes. Proc. 171st Nat. ACS Meeting, Div. Environ. Chem., New York, NY, April 4-9, 1976.

Ellestad, T.G. (1980). Aerosol Composition of Urban Plumes Passing over a Rural Monitoring Site. Annals of the N.Y. Acad. Sci., Vol. 338, 202-218.

Wilson, W.E. (1978). Sulfates in the Atmosphere: A Progress Report on Project MISTT. Atmospheric Environment, Vol. 12, 537-547.

Wilson, W.E. (1981). Sulfate Formation in Point Source Plumes: A Review of Recent Field Studies. Atmospheric Environment, Vol. 15, 2573-2581.

5.2 Washington University (WU)

Husar, R.B., D.L. Blumenthal, J. Anderson and W.E. Wilson (1974). The Urban Plume of St. Louis. Paper presented before the Div. of Environ. Chem., Amer. Chem. Soc., Los Angeles, March 28 - April 5, 1974.

Husar, R.B. (1974). Mobile Sampling Activities During the Summer 1974 RAPS Aerosol Program: Experimental Design. Technical Report, Air Pollution Research Lab, Washington Univ., May 2, 1974.

Husar, R.B. (1975). Summer 1975 Plume Mapping Program in St. Louis: Experimental Design. Technical Report, Air Pollution Research Lab, Washington University, May 20, 1975.

Husar, R.B., N.V. Gillani, J.D. Husar, S.B. Fuller, W.M. Vaughan and W. Dannevik (1975). Summary of Activities in Summer 1975 MISTT Study. Technical Report, Air Pollution Research Lab, Washington University.

Husar, R.B., N.V. Gillani, D.E. Patterson (1976). 1976 MISTT Program - Summary of Activities by Washington University and Environmental Measurements, Inc. Technical Report, Washington University.

Gillani, N.V., D.E. Patterson, R.B. Husar (1977). Project MISTT, 1976 - Data Volume, Washington University Aircraft (2 Volumes). Technical Report, Air Pollution Research Lab, Washington University, January 1977.

Gillani, N.V. and R.B. Husar (1976). Mathematical Modeling of Air Pollution - A Parametric Study. Proc. Second Fed. Conf. on Great Lakes, Argonne, Illinois, March 1975.

Husar, R.B., N.V. Gillani, J.D. Husar, S.B. Fuller, W.H. White, J.A. Anderson, W.M.Vaughan and W.E. Wilson (1976). Sulfur Budget in Large Plumes: Pollutant Flow Rate Measurements in the St. Louis Region.

Husar, R.B., N.V. Gillani and J.D. Husar (1976). Particulate Sulfur Formation in Power Plant, Urban and Regional Plumes. Paper presented at the Symposium on Aerosol Science and Technology, 82nd National Meeting of AIChE, Atlantic City, New Jersey, August 30 - September 1, 1976.

Husar, R.B., D.E. Patterson, C.C. Paley and N.V. Gillani (1976). Ozone in Hazy Air Masses. Proc. EPA International Conference on Photochemical Oxidant and its Control, Raleigh, North Carolina, September 1976.

Husar, R.B., N.V. Gillani, J.D. Husar, C.C. Paley and P.N. Turcu (1976). Long Range Transport of Pollutants Observed Through Visibility Contour Maps, Weather Maps and Trajectory Analysis. Preprints, Third Symp. Atmos. Turb., Diff. and Air Quality, AMS, Raleigh, North Carolina; October 19-22, 1976.

Norberg, C.A., R.B. Husar and D.E. Patterson (1978). Light Scattering Characteristics of an Aging Power Plant Plume. Paper presented at the Third Conf. on Atmospheric Radiation, Davis, California, June 28-30, 1978.

Husar, J.D., R.B. Husar, E.S. Macias, W.E. Wilson, J.L. Durham, W.K. Shepherd and J.A. Anderson (1976). Particulate Sulfur Analysis: Application to High Time Resolution Aircraft Sampling in Plumes. Atmospheric Environment, Vol. 10, 591-595.

Husar, R.B., J.P. Lodge and D.J. Moore (eds. 1978a). Sulfur in the Atmosphere, Proc. Int. Symp., Dubrovnik, Yugoslavia, September 7-14, 1977. (Published by Plenum Press, 1978).

Husar, R.B., D.E. Patterson, J.D. Husar and N.V. Gillani (1978b). Sulfur Budget of a Power Plant Plume. Atmospheric Environment, Vol. 12, 549-568.

Gillani, N.V., R.B. Husar, J.D. Husar and D.E. Patterson (1978). Project MISTT: Kinetics of Particulate Sulfur Formation in Power Plant Plumes out to 300 km. Atmospheric Environment, Vol. 12, 589-598.

Gillani, N.V., (1978). Project MISTT: Mesoscale Plume Modeling of the Dispersion, Transformation and Ground Removal of SO_2. Atmospheric Environment, Vol. 12, 569-588.

Cobourn, W.G., R.B. Husar and J.D. Husar (1978). Continuous *in-situ* Monitoring of Ambient Particulate Sulfur Using Flame Photometry and Thermal Analysis. Atmospheric Environment, Vol. 12, 89-98.

Gillani, N.V. and W.E. Wilson (1980). Formation and Transport of Ozone and Aerosols in Power Plant Plumes. Annals of N.Y. Acad. Sci., Vol. 338, 276-296.

Gillani, N.V., S. Kohli and W.E. Wilson (1981). Gas-to-Particle Conversion of Sulfur in Power Plant Plumes - I. Parameterization of Conversion Rate for Dry Moderately Polluted Ambient Conditions. Atmospheric Environment, Vol. 15, 2293-2313.

White, W.H., D.E. Patterson, and W.E. Wilson (1983). Urban Exports to the Non-Urban Troposphere: Results from Project MISTT. J. Geophys. Res. Vol. 88, pp. 10,745-10,752.

White, W.H. and D.E. Patterson (1983). Dispersion, Mixing, and Chemical Reaction in a Heterogeneous Urban-Industrial Plume. Paper No. 83-31.5, A.P.C.A. Annual Meeting, Atlanta, GA; June 1983.

Gillani, N.V., J.D. Shannon and D.E. Patterson (1984). Transport Processes, Ch. 3 in The Acidic Deposition Phenomenon and Its Effects: Critical Assessment Review Papers, Vol. 1.1. EPA-600/8-83-016 AF, July 1984.

5.3 Meteorology Research, Inc. (MRI)

White, W.H., J.A. Anderson, W.R. Knuth, D.L. Blumenthal and J.C. Hsiuing and R.B. Husar (1976). MISTT Project: Aerial Measurements of Urban and Power Plant Plumes, Summer 1974. EPA-600/3-76-110.

White, W.H., J.A. Anderson, J.C. Hsiuing, S.C. Gregg, R.B. Husar and K. Horton (1975). Aircraft Monitoring Support for an Aerosol Characterization Study in St. Louis - Summary Report (of 1974 Program). MRI 75 FR-1335; May 21, 1975.

MRI (1976). Aircraft Monitoring Support for an Aerosol Characterization Study in St. Louis - 1975 Program:

Vol. 1: Sampling Summary
Vol. 2: 1975 MISTT Data Volume
MRI 76 FR-1417; March 1976

Ogren, J.A., D.L. Blumenthal, J.A. Anderson, W.H. White (1977). MISTT: Aerial Measurements of Urban and Power Plant Plumes, Summer 1975 .... MRI Report of EPA Contract No. 68-02-2245.

MRI (1977). Aircraft Monitoring Support for Project MISTT:

Vol. 1: Sampling and Meteorological Summary
Vol. 2: Aircraft Data Volume
Vol. 3: Hydrocarbon Data Volume

Markowski, G.R. (1975). A Useful Method for Transient Response Analysis and Data Correction Applied to Aircraft Plume Sampling. Paper presented at the 68th Annual Meeting of the A.P.C.A., Boston, Massachusetts, June 1978.

White, W.H., J.A. Anderson, D.L. Blumenthal, R.B. Husar, N.V. Gillani, J.D. Husar and W.E. Wilson (1976). Formation and Transport of Secondary Air Pollutants: Ozone and Aerosols in the St. Louis Urban Plumes. Science, Vol. 194, 187-189.

White, W.H. (1977). NO_x-O_3 Photochemistry in Power Plant Plumes: Comparison of Theory with Observation. Environ. Sci. Technol., Vol. 11, 995-1000.

Blumenthal, D.L., J.A. Ogren and J.A. Anderson (1978). Airborne Sampling System for Plume Monitoring. Atmospheric Environment, Vol. 12, 613-620.

Smith, T.B., D.L. Blumenthal, J.A. Anderson and A.H. Vanderpol (1978). Transport of SO_2 in Power Plant Plumes: Day and Night. Atmospheric Environment, Vol. 12, 605-611.

Smith, T.B. (1981). Some Observations of Pollutant Transport Associated with Elevated Plumes. Atmospheric Environment, Vol. 15, 2197-2203.

5.4 Environmental Measurements, Inc. (EMI)

Vaughan, W.M. (1976). Moving Laboratory Field Measurements Executed by EMI for MISTT, July-August 1975: Final Report January 1976 (3 volumes).

Vaughan, W.M. (1977). Airborne COSPEC Measurements Executed by EMI during MISTT 1976: Summary. February 1977.

Vaughan, W.M., R.B. Sperling, N.V. Gillani and R.B. Husar (1975). Horizontal Mass Flow Rate Measurements in Plumes: A Comparison of Correlation-Spectrometer Data with a Dispersion and Removal Model. Paper presented at the 68th Annual Meeting of the A.P.C.A., Boston, Massachusetts, June 1975.

5.5 University of Minnesota (UMinn)

Cantrell, B.K. (1975). Preliminary Results from the 1974 St. Louis Aerosol Characterization Study. Particle Technology Lab, University of Minnesota, January 1975.

Whitby, K.T., B.K. Cantrell, R.B. Husar, N.V. Gillani, J.A. Anderson, D.L. Blumenthal and W.E. Wilson (1976). Aerosol Formation in a Coal-Fired Power Plant Plume. Paper presented before the Division of Environmental Chemistry, ACS Meeting, New York, New York, April 1976.

Whitby, K.T. (1978). The Physical Characteristics of Sulfur Aerosols. Atmospheric Environment, Vol. 12, 135-160.

Whitby, K.T., B.K. Cantrell and D.B. Kittelson (1978). Nuclei Formation Rates in a Coal-fired Power Plant Plume. Atmospheric Environment, Vol. 12, 313-322.

Cantrell, B.K. and K.T. Whitby (1978). Aerosol Size Distributions and Aerosol Volume Formation for a Coal-fired Power Plant Plume. Atmospheric Environment, Vol. 12, 323-334.

Whitby, K.T. (1980). Aerosol Formation in Urban Plumes. Annals New York Acad. Sci., Vol. 338, 258-275.

5.6 Rockwell International

Bryant, J.D. (1975). RAPS Final Report: Husar Plume Study Task Order No. 61. SC553. TO61FR, November 1975.

Waldron, T. (1976). RAPS Final Report: Husar Plume Study. Task Order No. 115. AMC 7010. TO115FR, November 1976.

5.7 Argonne National Laboratory

Hicks, B.B., G.D. Hess, M.L. Wesely, T. Yamada, P. Frengen, R.L. Hart, D.L. Sisterson, P.E. Hess, F.C. Kulhanek, R.C. Lipschutz and G.A. Zerbe (1981). The Sangamon Field Experiments: Observations of the Diurnal Evolution of the PBL Over Land. ANL/RER-81-1, September 1981.

5.8 Battelle Columbus Labs

Mendenhall, G.D., P.W. Jones, P.E. Strup and W. L. Margard (1978). Organic Characterization of Aerosols and Vapor Phase Compounds in Urban Atmospheres. EPA-600/3-78-031, March 1978.

Battelle Columbus Labs (1977). A Study of Aerosol Formation as a Function of Reactant Concentrations. Final Report to EPA Contract No. 68-02-2240.

Battelle Columbus Labs (1977). A Smog-Chamber Study of the Rate of Conversion of SO_2 as a Function of Reactant Concentrations. Final Report to EPA Contract No. 68-02-1720.

Miller, D.F. (1978). Precursor Effects on SO_2 Oxidation. Atmospheric Environment, Vol. 12, 273-280.

5.9 California Institute of Technology (CalTech)

Lamb, B.K., J.D. Bruchie and F.H. Shair (1975). Tracer Studies for Characterizing the Transport and Dispersion of Plumes Emitted at Ground and at Elevated Levels. Report to EPA Grant No. R802160-03-2; October 1975.

Overton, J.H., B.K. Lamb and F.H. Shair (1977). A Dual Tracer Study for Validation of Models with Respect to High and Low Altitude Sources. Proc. NATO/CCMS 7th International Technical Meeting on Air Pollution Modeling and Its Effects, Airlie, Virginia; September 1976.

5.10 Florida State University (FSU)

Winchester, J.W. and J.W. Nelson (1979). Sources and Transport of Trace Metals in Urban Aerosols. EPA-600/2-79-019; March 1979.

Pilotte, J.D., J.W. Nelson and J.W. Winchester (1976). Application of Multi-Station Time Sequence Aerosol Sampling and Proton Induced X-ray Emission Analysis Techniques to the St. Louis RAPS for Investigating Sulfur-Trace Metal Relationships. Proc. ERDA X- and Gamma-Ray Symp. Ann Arbor, Michigan, May 19-21, 1976.

Pilotte, J.D., J.W. Winchester and J.W. Nelson (1978). Components of Lead in the Atmosphere of St. Louis, Missouri. J. Appl. Meteorol., Vol. 17, 627-635.

Rheingrover, S.W. (1981). A Statistical Model for Titanium Pollution Transport and Dispersion in the Atmosphere of St. Louis. J. Appl. Meteorol., Vol. 20, 693-705.

5.11 SRI International

Uthe, E.E. and Wilson, W.E. (1979). Lidar Observations of the Density and Behavior of the Labadie Power Plant Plume. Atmospheric Environment, Vol. 13, 1395-1412.

5.12 Washington State University (WSU)

Rasmussen, R.A., R. Chatfield and M. Holdren (1977). Hydrocarbon and Oxidant Chemistry Observed at a Site Near St. Louis. EPA-600/7-77-056; June 1977.

5.13 Sandia National Lab (SANDIA)

Zak, B.D. (1981). Final Report on Project da Vinci: A Study of Long-Range Air Pollution Using a Balloon-Borne Lagrangian Measurement Platform.

Vol 1: Overview and Data Analysis
Vol 2: Reports of Participants in da Vinci I. SAND 78-0403/ 1 & 2.

5.14 The St. Louis Regional Air Pollution Study (RAPS)

Littman, F.E. (1977). RAPS Emission Inventory Handbook (Second Edition). Rockwell International Air Monitoring Center, Creve Coeur, Missouri. Task Order No. 108H Completion Report, EPA Contract 68-02-2093, April 1977.

Strothman, J.A. and Schiermeier, F.A. (1979). Documentation of the RAPS and Related Investigations in the St. Louis Air Quality Control Region. EPA-600/4-79-076; December 1979.

Mage, D.T. et al (1979). The RAPS Helicopter Air Pollution Measurement Program, St. Louis, Missouri, 1974-76. EPA-600/4-79-078; December 1979.

5.15 Union Electric Company (UE)

UE (1976). Monthly-Average Fuel and Hourly Power Generation Data. Union Electric Co., St. Louis, Mssouri.

UE (1976). Hourly Power Generation Data for Each Boiler Unit of Labadie (for selected MISTT mission days of 1976).

PART II - GENERAL DISTRIBUTION DATA BASE (GDDB)

1. OVERVIEW OF GDDB-MISTT

The MISTT data base currently (August 1984) resides at the WU/EPA Special Studies Data Center, Mechanical Engineering Department, Washington University, St. Louis, Missouri 63130. It consists of the following major components:

1. The Field Data Base - the raw and partially processed aircraft and pibal field data computerized and plotted at the WU data center during the MISTT field intensive periods. This data base includes the raw aircraft flight logs and angular pibal data sheets, as well as computer plots used for on-site data review.
2. The Intermediate Data Base - a version of the final computerized data base (the GDDB) in a direct-access format suitable for input to our display/edit interactive graphics software package (EDITR).
3. The Final Data Base - consisting of two parts, viz. a) the General Distribution Data Base (GDDB), which is the portion of the "clean" MISTT data which are on magnetic tapes, and b) MISTT Reports and Publications, which partially contain the only available form of the data of some of the measurement platforms, and otherwise contain the detailed descriptions of the platforms, the measurements, quality assurance, and research results of the MISTT program.

In this Part II of the current Project MISTT report, we describe and document the General Distribution Data Base of Project MISTT (MISTT/GDDB). Part II will normally accompany any distribution of the MISTT final data on magnetic tapes to potential users. The remainder of the Final Data Base, i.e. the MISTT Reports and Publications, are listed in Chapter 5 of Part I of this report.

MISTT/GDDB is that portion of the final MISTT data which is archived on magnetic tapes. It represents the core of the MISTT base. Requests for it should be addressed

Chief, Data Management Branch
Meteorology and Assessment Division, MD-80
Atmospheric Sciences Research Lab
EPA, Research Triangle Park, NC 27711

Telephone: (919)541-4545 (FTS 629-4545).

The MISTT data base, in its entirety, will continue to reside at Washington University.

MISTT/GDDB is itself a subset of a larger data base pertaining to several EPA-sponsored special field studies. The other members of that larger data base are similar GDDBs of Projects STATE-TPS (Tennessee Plume Study), PEPE/NEROS (Persistent Elevated Pollution Episode/ Northeast Regional Oxidant Study), and CWPS (Cold Weather Plume Study). The GDDBs are in a highly standardized form. All the data collected specifically as part of these studies and included in GDDB form, are in one or the other of two data file formats, viz. the STATE-20 and the STATE-VS. Both are simple, sequential, 80-character card image formats consisting of a self-documenting header leading the actual data records, which are followed by a comments section (as needed). STATE-20 is used for data of a time series nature in which each of the sequential data records contains time and the corresponding data of the measured parameters. The header provides a variety of information including identification of the data variables, their units and physical ranges, as well as the specific format of the data records. The comment provides any special information, including definition of variable names which are not self-explanatory. STATE-VS is used for data of vertical soundings. Each file contains the data of all soundings of a given type (e.g. pibal soundings) of a given mission, and the data of each sounding is contained within a subfile. Each subfile is self-documented by a leading header and a trailing comment (as needed), which give information specific to the given sounding (e.g. pibal launch site and time, etc.). There is also a main file header preceding all the subfiles, and main file comments (as needed) trailing all the subfiles; these document features common to all soundings (e.g. type of sounding, measured variables and their units, and the specific common format of the subfile data records). Complete documentation of STATE-20 and STATE-VS is given in Appendix D - Tape and File Formats.

MISTT/GDDB contains data collected by MRI, WU, EMI, Rockwell and ANL during the summer field programs of 1975 and 1976. Tables II.1 and II.2, respectively for 1975 and 1976, outline more specifically the data included in the GDDB. The data for each year are presented on separate magentic tapes. For a given year, the data files of MRI, WU (only 1976), EMI and Rockwell are organized sequentially by day (i.e. mission). Following all the daily sets of these data files, covering the entire field study period, is a single ANL file containing the ANL data of the whole study period. The ANL data were not broken down by day because of their rather small total volume. The structure of the GDDB of each year thus has the following form:

- MRI, WU, EMI, Rockwell data files of mission 1
- MRI, WU, EMI, Rockwell data files of mission 2

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- MRI, WU, EMI, Rockwell data files of last mission
- ANL data file of all missions of this year

TABLE 20

MISTT 1975

FINAL DATA BASE ON MAGNETIC TAPES

ORGANIZATION	DATA DESCRIPTION	DATA AVERAGING TIME	FILE FORMAT
MRI(1,2,3)	Aircraft data of 15 sampling missions Parameters: Date, Time, Altitude, VOR,DME, Temperature, Dew Point, Turbulence, SO_2, NO, NO_x, Ozone, B_{scat}, CNC	Approx. 1 sec.	STATE - 20
EMI	AQML data of 20 sampling missions Parameters: Date, Time, Location (UTM x,y and LAT/LONG) Total Gaseous S, NO_x, B_{scat}, Charge, COSPEC (SO_2, NO_2)	10 sec.	STATE - 20
ROCKWELL	Mobile pibal data of 16 missions and 362 soundings Parameters: Date, Time, Location, Wind speed/direction at different heights	-	STATE - VS
ANL	Micrometeorological data of 17 days Parameters: Date, Time, Total and net radiation, sensible heat flux (H_o), Friction velocity (U_*, by two different methods), surface wind speed and direction (at 1.3 m), ambient and wet bulb temperature	30 min.	STATE - 20

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1. The continuous data included here are for the MRI standard measurements. The discrete data of aerosol size distribution measurements are in the custody of UMinn.
2. The data of aerosol sulfur based on filter samples, and the information concerning VOR stations, are given in Tables in appropriate appendices to part II of this report.
3. The MRI data files corresponding to cartridges 454-458 (7/29-30), 460(8/6), 461-462 (8/7-8), and 463 (last part of 8/10) were not available at 1s. An alternate version, averaged at approx. 10s, and including the data of traverses as well as spirals, is included instead.

TABLE 21

MISTT 1976

FINAL DATA BASE ON MAGNETIC TAPES

ORGANIZATION	DATA DESCRIPTION	DATA AVERAGING TIME	FILE FORMAT
MRI(1,2)	Aircraft data of 14 sampling missions Parameters: Date, Time, Altitude, VOR, DME, Temperature, Dew point, Turbulence, SO_2, NO, NO_x, Ozone, B_{scat}, CNC, Charge	Approx. 9 sec.	STATE - 20
WU	Aircraft data of 14 sampling missions Parameters: Date, Time, Altitude, VOR, DME, VOR Station Code (Code description given in accompanying documentation), SO_2, Ozone, B_{scat}, Charge, CNC, S_p	∿ 10 sec.	STATE - 20
EMI	Aircraft COSPEC data of 4 sampling missions (*) Parameters: Date, Time, Altitude, UTM-(x,y) in zone 15, LAT/LONG, COSPEC - SO_2 (*) July 14, 18, 23, 28	3 sec.	STATE - 20
ROCKWELL	Mobile pibal data of 16 missions and 573 soundings Parameters: Date, Time, Location, Wind speed/direction at different heights	-	STATE - VS
ANL	Micrometeorological data of 12 days Parameters: Date, Time, Total and net radiation, sensible heat flux (H_o), Friction velocity (U_*, by two different methods), surface wind speed and direction (at 1.3 m), ambient and wet bulb temperature	30 min.	STATE - 20

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1. The continuous data included here are for the MRI standard measurements. The discrete data of aerosol size distribution measurements are in the custody of UMinn.
2. The data of aerosol sulfur based on filter samples, and the information concerning VOR stations, are given in Tables in appropriate appendices to part II of this report.

TABLE 22

PROJECT MISTT

Types of Data Files in GDDB*

File Name	Platform/Data	File Format
MRI75T.mdd*	MRI aircraft data of traverses (T) for mission starting on "mdd75", m = month (7 = July, 8 = August) dd = day (dd = 1 to 31)	STATE-20
MRI75S.mdd*	MRI aircraft data of spirals (S) for mission starting on "mdd75"	STATE-20
MRIyy.mdd	MRI aircraft data (traverses and spirals) for mission starting on "mddyy", where yy = year (75 or 76)	STATE-20
WUyy.mdd	WU aircraft data (traverses and spirals) of mission starting on "mddyy"	STATE-20
EMI 75 .mdd	EMI 1975 AQML data of mission of "mddyy"	STATE-20
EMI 76 .mdd	EMI 1976 COSPEC-aircraft data of mission of "mddyy"	STATE-20
PIyy.mdd	Rockwell mobile pibal data of "mddyy"	STATE-VS
	Above file types included in daily data sets	
ANLyy	ANL micrometeorological data file of year yy.	STATE-20

*MRI logged data on three cartridges on 10 August 1975. The clean data of the first two of these cartridges at the original data logging rate of 1 second were available, and are included in files MRI75T.810 and MRI75S.810. The data of the third cartridge were not available at 1 sec. An alternate version with data of 10 records averaged into 1, (hence approx. 10s average data) of the data on the last cartridge (#463) is included in the data base instead. The corresponding file is named M75463.810.

Table II.3 identifies and defines the type of data files in the GDDB of MISST. In any given mission, not all platforms may have participated. The actual data files present in a given mission data set are identified in a daily summary file (called FILSyy.mdd) which appears as the first file of a daily data set. A listing of these daily summary files for both years are presented in Appendix E - Daily Data Base Summary Files.

As a documentation of the contents of each type of data file in the GDDB, we present an actual dump of the header, a few data records at the beginning and end of the file, and the comments of each file in the daily data set of 18 July 1976 in Appendix F - Sample Listings of Contents of Data Files. This Appendix also contains a similar partial dump of the ANL file for 1976, as well as of the EMI AQML file of 18 July 1975. The information contained in Tables II.1, II.2 and II.3, the documentation of the formats STATE-20 and STATE-VS, and the self-documentation in file headers and comments is collectively fully sufficient to enable users to properly access the data in the GDDB.

There are two significant types of essential information which are either absent or incomplete in the data files. The first concerns the navigational information. The MRI aircraft data channels include VOR/DME, but not the station information. This is given in tabulated and self-explanatory form in Appendix C - VORTACs. The WU aircraft data channels include, in addition to VOR/DME, a channel called VORSTN. This channel contains an integer code with values ranging from 0 to 50. The value 0 denotes that the station information is either not known or that there are no valid VOR/DME data in that record. Values between 1 and 50 correspond to specific VOR stations which are identified adequately in an appropriate Table in Appendix C - VORTACs.

Missing from the MRI files, but included in the WU files, are the data of aerosol sulfur concentrations based on integrated filter samples. The MRI data of average particulate sulfur concentration (S_p) for each sample are tabulated in Appendix B - S_p.

We believe that Part II and its Appendices provide all necessary documentation of the GDDB. Should there be any questions concerning the GDDB, please feel free to contact:

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APPENDIX B - S_p

(MRI 1975)

CAUTION: The particulate sulfur concentration data included here are as supplied by J.D. Husar of Washington University, who was responsible for the filter sample analyses for particulate sulfur by the flash volatilization - flame photometric detection (FPD) method. The S_p data of 7/18/75 have been used in previous data analyses and are apparently of good quality. The quality of the data of other missions, however, has neither been tested nor assessed to date.

MISTT 1975

PARTICULATE SULFUR (S_p) DATA

Date: July 18, 1975

AIRCRAFT	SAMPLE #	SAMPLE TIME	S_p CONCENTRATION ($\mu g/m^3$)
MRI	2	0658 - 0710	1.75
	3	0718 - 0723	1.60
	4	0727 - 0733	1.00
	5	0739 - 0744	3.60
	6	0746 - 0752	0.83
	7	0757 - 0802	3.00
	8	0824 - 0836	1.50
	9	0849 - 0906	2.17
	10	0909 - 0925	1.57
	11	0927 - 0945	2.94
	12	1130 - 1142	5.50
	13	1157 - 1220	3.47
	14	1224 - 1246	3.72
	15	1251 - 1310	3.52
	16	1312 - 1319	1.57
	17	1325 - 1345	4.90
	18	1348 - 1410	6.86
	19	1412 - 1433	3.71
	20	1546 - 1558	2.38
	21	1607 - 1627	7.45
	22	1631 - 1656	5.96
	23	1657 - 1719	2.63
	24	1729 - 1758	4.24
	25	1804 - 1814	7.10
	26	1816 - 1839	2.13
	27	1842 - 1855	5.92

MISTT 1975

PARTICULATE SULFUR (S_p) DATA

Date: July 21, 1975

AIRCRAFT	SAMPLE #	SAMPLE TIME	S_p CONCENTRATION ($\mu g/m^3$)
MRI	1	0640 - 0655	2.13
	3	0711 - 0720	10.90
	4	0727 - 0748	2.33
	5	0824 - 0837	3.61
	6	0841 - 0854	3.69
	8	0913 - 0926	4.23
	9	0940 - 0951	5.36
	11	1149 - 1202	2.30
	12	1207 - 1212	19.00
	14	1218 - 1226	7.13
	15	1229 - 1239	7.80

MISTT 1975

PARTICULATE SULFUR (S_p) DATA

Date: July 22, 1975

AIRCRAFT	SAMPLE #	SAMPLE TIME	S_p CONCENTRATION ($\mu g/m^3$)
MRI	1	0726 - 0738	3.50
	2	0743 - 0751	1.62
	3	0752 - 0801	1.33
	4	0813 - 0827	6.71
	5	0830 - 0845	2.26
	6	0848 - 0902	0.78
	7	0907 - 0916	2.33
	8	0950 - 1002	1.08
	9	1015 - 1019	2.25
	10	1020 - 1030	1.80
	11	1033 - 1036	2.33
	13	1041 - 1050	4.55
	14	1052 - 1101	6.77
	15	1108 - 1117	3.77
	16	1309 - 1319	2.30
	17	1333 - 1339	8.16
	18	1341 - 1354	6.00
	19	1358 - 1411	4.07

MISTT 1975

PARTICULATE SULFUR (S_p) DATA

Date: July 24, 1975

AIRCRAFT	SAMPLE #	SAMPLE TIME	S_p CONCENTRATION ($\mu g/m^3$)
MRI	1	2113 - 2118	1.20
	2	2121 - 2126	3.60
	3	2129 - 2134	4.00
	4	2139 - 2143	3.50
	5	2145 - 2149	0.75
	6	2201 - 2205	2.50
	7	2207 - 2210	3.33
	8	2213 - 2217	1.25
	9	2219 - 2223	1.00
	10	2228 - 2231	3.33
	11	2233 - 2236	2.00
	12	2238 - 2241	5.00
	13	2243 - 2246	6.67
	14	2300 - 2307	1.00
	15	2317 - 2322	1.00
	16	2325 - 2331	2.00
	17	2332 - 2338	2.67
	18	2342 - 2347	1.20
	19	2348 - 2345	0.66
	20	0003 - 0012	1.00
	21	0211 - 0216	2.00
	22	0219 - 0224	5.80
	23	0227 - 0232	2.20
	24	0235 - 0245	1.20
	25	0248 - 0256	0.62
	26	0303 - 0308	0.60
	27	0318 - 0321	1.33
	28	0325 - 0330	3.20
	29	0350 - 0358	20.12
	30	0400 - 0409	0.55
	31	0424 - 0428	1.50
	32	0430 - 0434	1.75

MISTT 1975

PARTICULATE SULFUR (S_p) DATA

Date: July 29, 1975

AIRCRAFT	SAMPLE #	SAMPLE TIME	S_p CONCENTRATION ($\mu g/m^3$)
MRI	1	1334 - 1341	23.71
	2	1344 - 1351	18.29
	3	1354 - 1400	12.50
	4	1402 - 1409	20.00
	5	1418 - 1426	16.13
	6	1444 - 1458	18.71
	7	1501 - 1511	14.50
	8	1524 - 1540	15.56
	9	1546 - 1556	29.50
	10	1620 - 1627	21.85
	11	1642 - 1656	27.93
	12	1659 - 1720	14.43
	13	1854 - 1920	10.81
	14	1948 - 2009	17.33
	15	2024 - 2032	13.38
	17	2056 - 2119	13.04
	18	2123 - 2145	22.95
	19	2148 - 2209	23.57
	20	2222 - 2231	23.56

MISTT 1975

PARTICULATE SULFUR (S_p) DATA

Date: July 30, 1975

AIRCRAFT	SAMPLE #	SAMPLE TIME	S_p CONCENTRATION ($\mu g/m^3$)
MRI	1	0014 - 0026	13.08
	2	0042 - 0056	15.70
	3	0056 - 0118	18.63
	4	0118 - 0133	27.00
	5	0139 - 0156	15.17
	6	0156 - 0219	12.70
	7	0219 - 0233	15.20
	8	0246 - 0258	8.25
	9	0304 - ?	18.20
	10	? - 0346	25.94
	11	0519 - 0531	17.67
	12	0531 - 0543	17.50
	13	0544 - 0555	20.27
	14	0555 - 0612	9.41
	15	0612 - 0626	10.36
	16	0626 - 0640	11.57
	17	0648 - 0719	9.23
	18	0739 - 0755	13.88
	19	0755 - 0815	14.00
	20	0815 - 0833	19.22
	21	0836 - 0853	16.25
	23	1034 - 1052	11.05
	24	1054 - 1111	11.23
	25	1111 - 1125	16.21

MISTT 1976

PARTICULATE SULFUR (S_p) DATA

Date: August 3, 1976

AIRCRAFT	SAMPLE #	SAMPLE TIME	S_p CONCENTRATION ($\mu g/m^3$)
WU	114	1043:35 - 1105:50	2.00
	115	1106:55 - 1135:10	0.92
	116	1136:55 - 1218:45	2.11
	117	1219:45 - 1241:03	3.43
	118	1242:30 - 1309:03	2.82
	119	1310:10 - 1319:49	1.55
	120	1449:31 - 1525:40	2.25
	121	1528:50 - 1548:15	1.65
	122	1550:20 - 1615:00	4.06
	123	1615:55 - 1639:30	3.41
	124	1640:25 - 1652:25	3.63
	125	1653:18 - 1718:40	3.45
	126	1719:45 - 1742:45	3.13
	127	1857:05 - 1924:25	2.93
	128	1925:35 - 1954:40	2.27
	129	1955:35 - 2013:45	4.38
	130	2014:33 - 2045:15	2.41
	131	2046:20 - 2117:30	1.62

MISTT 1975

PARTICULATE SULFUR (S_p) DATA

Date: August 10, 1975

AIRCRAFT	SAMPLE #	SAMPLE TIME	S_p CONCENTRATION ($\mu g/m^3$)
MRI	1	0708 - 0713	5.80
	4	0724 - 0729	4.60
	6	0736 - 0741	3.80
	7	0754 - 0750	3.00
	8	0752 - 0758	3.17
	10	0804 - 0809	10.00
	11	0811 - 0816	8.00
	12	0817 - 0822	6.20
	13	0823 - 0828	2.00
	14	1032 - 1037	10.80
	15	1038 - 1043	5.20
	16	1044 - 1049	2.40
	18	1056 - 1101	2.00
	19	1102 - 1107	5.40
	23	1140 - 1145	6.80
	24	1147 - 1154	6.85
	25	1156 - 1206	8.20
	26	1207 - 1212	4.00
	27	1214 - 1219	9.00
	28	1222 - 1232	9.10
	29	1233 - 1238	12.23
	30	1246 - 1251	10.55
	32	1315 - 1325	6.70
	33	1335 - 1345	7.00
	35	1528 - 1538	8.60
	36	1550 - 1600	4.10
	37	1708 - 1718	11.40
	38	1719 - 1729	9.40
	39	1734 - 1744	3.80

MISTT 1975

PARTICULATE SULFUR (S_p) DATA

Date: August 11, 1975

AIRCRAFT	SAMPLE #	SAMPLE TIME	S_p CONCENTRATION ($\mu g/m^3$)
MRI	1	0746 - 0758	3.78
	2	0811 - 0824	9.78
	3	0851 - 0904	25.15
	4	0906 - 0923	14.63
	5	0924 - 0941	3.98
	6	0957 - 1007	44.28
	7	1011 - 1016	45.39
	8	1019 - 1036	16.06
	9	1038 - 1053	23.91
	11	1151 - 1202	7.36
	12	1202 - 1215	3.04
	13	1218 - 1230	4.07
	14	1230 - 1241	41.90
	15	1245 - 1256	26.52
	16	1256 - 1311	22.55

APPENDIX - S_p

(MRI and WU, 1976)

MISTT 1976

PARTICULATE SULFER (S_p) DATA

Date: July 1, 1976

AIRCRAFT	SAMPLE #	SAMPLE TIME	S_p CONCENTRATION ($\mu g/m^3$)
MRI	55.1	0852 - 0949	(I)
	56.0	1011 - 1016	3.03
	56.8	1019 - 1054	(I)
	57.5	1102 - 1107:45	1.61
	58.3	1115 - 1129	1.52

(I) = Inadequate data

MISTT 1976

PARTICULATE SULFUR (S_p) DATA

Date: July 2, 1976

AIRCRAFT	SAMPLE #	SAMPLE TIME	S_p CONCENTRATION ($\mu g/m^3$)
MRI	65	0844 - 0925	2.44
	66	0939 - 1003	4.02
	66.5	1007 - 1033	3.02
	67	1041 - 1104	3.33
	68	1125 - 1140	2.67
	69	1316 - 1334	3.14
	69.7	1347 - 1415	3.18
	70.5	1422 - 1455	3.23
	71.5	1458 - 1527	3.14
	72	1531 - 1601	2.50
	73	1606 - 1636	2.90

MISTT 1976

PARTICULATE SULFER (S_p) DATA

Date: July 5-6, 1976

AIRCRAFT	SAMPLE #	SAMPLE TIME	S_p CONCENTRATION ($\mu g/m^3$)
MRI	79.3	1108 - 1125:50	1.39
	80.2	1155 - 1248	1.77
	81.0	1257 - 1304	(I)
	81.8	1312 - 1409	2.03
	82.6	1418 - 1434	5.36
	83.4	1628 - 1815	1.79
	84.2	1834 - 1852	3.15
	85	2114 - 2128	1.71
	86	2161 - 2157	2.81
	87	2207 - 2224	0.23(Q)
	87.7	2238 - 2255	3.65
	89	2330 - 2352	2.18(Q)
	90	0214 - 0233	4.05
	90.8	0236 - 0256	1.75
	91.5	0317 - 0322	6.20
	92	0327 - 0332	3.60
	93	0336 - 0341	3.80
	94	0346 - 0356	4.20
	95	0400 - 0445	2.01

(I) = Inadequate data (Q) = Questionable data

MISTT 1976

PARTICULATE SULFER (S_p) DATA

Date: July 5-6, 1976 cont.

AIRCRAFT	SAMPLE #	SAMPLE TIME	S_p CONCENTRATION ($\mu g/m^3$)
WU	70	1549 - 1611	0.45
	71	1630 - 1657	<0.1
	158	1858 - 1917	0.89
	159	1919 - 1930	2.36
	160	1935 - 1952	0.73
	161	1955 - 2004	2.17
	171	2248:30 - 2257	<0.1
	172	2258 - 2304	2.75
	173	2317:30 - 2325:30	1.08
	174	2329:30 - 2346	0.70
	175	0005:30 - 0013:30	3.44
	176	0023 - 0040	1.00
	177	0046 - 0105	<0.1
	179	0414 - 0427	0.96
	180	0449:30 - 0500:20	0.34

(I) = Inadequate data (Q) = Questionable data

MISTT 1976

PARTICULATE SULFUR (S_p) DATA

Date: July 7, 1976 p.1 of 2

AIRCRAFT	SAMPLE #	SAMPLE TIME	S_p CONCENTRATION ($\mu g/m^3$)
MRI	102	0904 - 0915	2.09
	103.6	0938 - 0948	4.52
	104.4	0948 - 0958	3.62
	105.3	1012 - 1021	2.95
	106.2	1021 - 1031	1.52
	106.9	1035 - 1045	2.34
	107.6	1045 - 1055	3.52
	108.5	1107 - 1117	2.67
	109.4	1129 - 1136	2.92
	110.2	1139 - 1151	3.27
	111.0	1151 - 1201	4.22
	111.8	1207 - 1216	4.78
	112.6	1216 - 1226	2.28
	113.5	1430 - 1441	3.71
	114.3	1441 - 1451	1.27
	115.2	1455 - 1505	3.39
	116.0	1505 - 1514	1.41
	116.8	1520 - 1531	3.25
	117.6	1531 - 1540	3.26
	118.5	1555 - 1618	3.48
	119.3	1629 - 1634	2.91
	120.2	1639 - 1651	3.08
	121.0	1651 - 1703	1.96
	121.8	1709 - 1722	2.65
	122.6	1722 - 1736	2.67
	123.5	1739 - 1750	3.59
	124.3	1754 - 1803	5.18

MISTT 1976

PARTICULATE SULFUR (S_p) DATA

Date: July 7, 1976 p.2 of 2

AIRCRAFT	SAMPLE #	SAMPLE TIME	S_p CONCENTRATION ($\mu g/m^3$)
WU	194	1040 - 1050	1.30
	195	1058 - 1108	0.90
	196	1108 - 1114	1.83
	197	1115 - 1123	1.12
	198	1123 - 1131	1.00
	199	1132 - 1142	0.50
	200	1142 - 1148	0.83
	201	1156 - 1201	1.40
	202	1256 - 1304	1.62
	203	1304 - 1312	1.75
	204	1327 - 1334	1.00
	205	1335 - 1409	2.23
	206	1414 - 1433	1.68
	207	1434 - 1447	2.77
	208	1457 - 1504	2.14
	209	1508 - 1515	2.00
	210	1515 - 1532	2.29
	211	1659 - 1716	1.53
	211.33	1718 - 1735	2.59
	211.67	1739 - 1742	1.33
	212	1746 - 1806	2.55
	212.33	1808 - 1827	2.73
	212.67	1848 - 1910	2.27
	213	1920 - 1930	1.40
	213.33	1935 - 1942	2.14

MISTT 1976

PARTICULATE SULFUR (S_p) DATA

Date: July 9, 1976

AIRCRAFT	SAMPLE #	SAMPLE TIME	S_p CONCENTRATION ($\mu g/m^3$)
WU	002	0737:00 - 0746:00	2.22
	003	0750:23 - 0755:45 0759:55 - 0806:45	3.83
	004	0809:05 - 0815:55 0817:17 - 0824:30	3.00
	005	0825:25 - 0833:00	5.78
	006	0845:33 - 0852:45	3.14
	007	0857:28 - 0905:45	0.97
	008	0908:04 - 0916:38	1.53
	009	0920:02 - 0927:57	2.95
	010	0937:00 - 0943:30	2.00
	011	1038:00 - 1045:07	3.71
	012	1048:04 - 1057:55	3.75
	013	1100:08 - 1117:15	Voided
	014	1120:00 - 1134:55	2.95
	015	1139:50 - 1150:00	3.90
	016	1151:50 - 1159:40	3.44
	017	1211:37 - 1218:30	2.03
	018	1233:02 - 1247:20	3.99
	019	1304:51 - 1320:15	1.75
	020	1515:00 - 1523:30	3.64
	021	1530:15 - 1543:30	5.66
	022	1545:30 - 1600:20	5.47
	023	1612:07 - 1620:05	5.10
	024	1629:45 - 1646:34	4.16
	030	1955:05 - 2019:30	4.19
	031	2024:25 - 2047:10	2.22
	032	2057:05 - 2110:30	2.77
	033	2114:30 - 2127:53	4.15
	034	2134:30 - 2141:50	
	035	2142:56 - 2149:26	5.22
	036	2149:56 - 2203:30	3.36
	037	2335:07 - 2342:30	1.92
	038	2343:58 - 0004:20	2.81
	039	0005:05 - 0011:00	0.86
	040	0011:45 - 0028:30	2.02
	041	0042:30 - 0057:10	1.73
	042	0125:48 - 0135:00	2.09
	043	0135:37 - 0143:15	2.06
	044	0241:40 - 0350:00	1.54

MISTT 1976

PARTICULATE SULFUR (S_p) DATA

Date: July 12, 1976

AIRCRAFT	SAMPLE #	SAMPLE TIME	S_p CONCENTRATE ($\mu g/m^3$)
WU	50	1342:11 - 1349:42	1.65
	51	1354:00 - 1402:20	4.49
	52	1405:53 - 1414:06	1.41
	53	1416:32 - 1424	0.66
	54	1437:26 - 1443:04	1.93
	55	1455:08 - 1506:02	1.63
	56	1509:20 - 1519:51	2.55
	57	{1523:39 - 1527:24 1527:51 - 1534:39}	3.20

MISTT 1976

PARTICULATE SULFUR (S_p) DATA

Date: July 13, 1976

AIRCRAFT	SAMPLE #	SAMPLE TIME	S_p CONCENTRATE ($\mu g/m^3$)
WU	64	1332:47 - 1342:15	3.65
	65	1348:07 - 1358:30	2.75
	66	1402:00 - 1411:35	3.59

MISTT 1976

PARTICULATE SULFUR (S_P) DATA

Date: July 14, 1976

AIRCRAFT	SAMPLE #	SAMPLE TIME	S_P CONCENTRATION ($\mu g/m^3$)
MRI	152.5	0618 - 0648	1.32
	153	0650 - 0701	2.95
	154	0704 - 0713	1.17
	155	0717 - 0753	1.28
	155.7	0757 - 0831	3.69
	156.5	0836 - 0848	1.67
	157	0853 - 0901	0.25
	158	0914 - 0944	1.83
	159	0951 - 1001	1.75
WU	73	0527:21 - 0537:31	2.62
	74	0539:31 - 0551:15	0.46
	75	0552:51 - 0603:41	0.82
	76	0604:49 - 0623:56	2.02
	77	0625:08 - 0638:30	1.107
	78	0639:30 - 0657:09	1.12
	79	0659:17 - 0716:57	0.98
	80	0718:01 - 0736:07	1.99
	81	0737:13 - 0757:51	1.11
	82	0759:14 - 0810:43	1.01
	83	0942:32 - 0956:40	1.04
	84	0957:33 - 1014:01	2.15
	85	1015:19 - 1028:00	1.16
	86	1028:47 - 1046:08	1.25
	87	1058 - 1121	0.39

MISTT 1976

PARTICULATE SULFUR (S_p) DATA

Date: July 15, 1976

AIRCRAFT	SAMPLE #	SAMPLE TIME	S_p CONCENTRATION ($\mu g/m^3$)
MRI	170.3	0823:10 - 0835:05	0.59
	171.2	0852:30 - 0929:55	1.21
	171.8	0941:40 - 0952:12	0.71
	172.7	1001:58 - 1019:25	0.70
	173.5	1033:50 - 1102:10	1.24
	174.3	1130:55 - 1145:50	3.19
	176	1349:30 - 1359:30	0.00
	176.8	1419:35 - 1518:20	0.67
WU	94	0732:51 - 0740:41	0.043
	95	0750:08 - 0806:22	1.39
	97	0808:40 - 0810:30	0.53
	98	0819:04 - 0839:39	0.796
	99	0900:19 - 0909:33	0.61
	100	0911:08 - 0918:58	0.186
	101	0921:15 - 0928:45	0.00
	102	0934 - 0937:21	0.94
	159	1115:20 - 1222:29	1.22
	160	1158:34 - 1213:15	1.36
	161	1217:04 - 1230:52	2.10
	162	1233:50 - 1249:55	1.64
	163	1250:48 - 1300:18	1.03
	164	1301:40 - 1315:05	1.51
	165	1319:31 - 1326:20	1.88
	166	1351:37 - 1900:41	2.18

MISTT 1976

PARTICULATE SULFUR (S_p) DATA

Date: July 18, 1976

AIRCRAFT	SAMPLE #	SAMPLE TIME	S_p CONCENTRATION ($\mu g/m^3$)
MRI	189	0739 - 0745:49 0748:57 - 0755:20 0801:30 - 0809:05	0
	190	0817:00 - 0824:30	0.40
	191	0829:02 - 0836:40	2.09
	192	0839:15 - 0846:40	0
	193	0918:45 - 0928:00	0.27
	193.5	1456:54 - 1507:29	2.97
	194.5	1520:18 - 1530:45 1535:15 - 1545:28 1552:52 - 1607	2.18
	195	1701:05 - 1712:20	1.29
	196	1720:17 - 1734:40	0
	196.8	2107 - 2115 2132 - 2138 2143 - 2150 2151 - 2155	0.76
	197.7	2221 - 2026 2228 - 2233	0
	198.5	2247 - 2252 2312 - 2318 2324 - 2336	4.20
	199.5	2358 - 2303	0
	200	0006 - 0016:56	2.95
	201	0019 - 0031	6.50

MISTT 1976

PARTICULATE SULFUR (S_p) DATA

Date: July 18, 1976

AIRCRAFT	SAMPLE #	SAMPLE TIME	S_p CONCENTRATION ($\mu g/m^3$)
WU	176	1411:33 - 1421:41	1.3
	177	1426:19 - 1435:26	2.44
	178		0
	179	1437:29 - 1456:10	2.33
	180	1457:53 - 1512:13	3.14
	181	1519:31 - 1532:07	0.68
	182	1535:31 - 1549:43	2.96
	183	1554:43 - 1606:01	3.99
	184	1608:29 - 1620:29	3.08
	185	1629:00 - 1641:02	4.25
	186		0
	187	1813:04 - 1826:44	4.9
	188	1835:53 - 1844:06	4.34
	189	1850:24 - 1905:01	3.92
	190	1911:56 - 1924:34	3.53
	191	1932:54 - 1939:14	1.52
	192	1951:53 - 2012:04	3.99
	196	0029:11 - 0057:30	3.57
	197	0121:29 - 0126:30	3.07

MISTT 1976

PARTICULATE SULFUR (S_p) DATA

Date: July 20, 1976

AIRCRAFT	SAMPLE #	SAMPLE TIME	S_p CONCENTRATION ($\mu g/m^3$)
MRI	5.2	1054:55 - 1105:30	1.89
	6.0	1117:05 - 1123:10	0.88
	6.8	1128:30 - 1134:20	2.74
	7.6	1141:20 - 1146:50	0
	8.4	1153:11 - 1204:00	0.80
	9.2	1222:25 - 1232:30	0.86
	10.0	1238:00 - 1249:20	0.59
	10.8	1257:40 - 1312:35	1.89
	11.6	1326:10 - 1341:20	0.97
	12.4	1352:35 - 1408:10	1.84
	13.2	1539:20 - 1554:30	0.22
	14.0	1612:33 - 1631:15	2.39
	14.8	1637:05 - 1654:10	1.48
	15.6	1709:50 - 1716:50	0.86
	16.4	1723:50 - 1735:40	2.76
	17.2	1741:35 - 1758:40	3.24
	18.0	1813:05 - 1824:32	2.63
	18.8	1828:05 - 1838:30	2.82
	19.6	1842:30 - 1852:30	0.47
	20.4	1856:05 - 1907:00	1.64
	21.2	1918:40 - 1934:15	1.42
	23.0	2116:35 - 2138:40	2.03
	24.0	2143:15 - 2201:51	0.79
	24.5	2211:29 - 2231:34	0.897
	25.0	2325:15 - ?	2.04
	26.0	2357 - 0013:41	1.04
	27	0016:39 - 0029:45	0.46

MISTT 1976

PARTICULATE SULFUR (S_p) DATA

Date: July 20, 1976

AIRCRAFT	SAMPLE #	SAMPLE TIME	S_p CONCENTRATION ($\mu g/m^3$)
WU	001	2008:42 - 2016:02	1.97
	002	2158:45 - 2215:01	1.42
	003	2221:13 - 2241:03	0.88
	004	2214:52 - 2229:50	1.25
	005	2243:49 - 0101:10	0.89
	006	0108:54 - 0120:26	1.34
	015	0152:33 - 0201:25	0.87
	016	0126:30 - 0141:11	2.89
	017	0142:00 - 0152:28	1.34
	018	0153:04 - 0206:53	0.91
	019	0207:42 - 0217:00	0.88
	201	1041:43 - 1051:34	1.51
	202	1054:05 - 1108:53	1.28
	203	1112:15 - 1119:07	1.69
	204	1122:27 - 1142:47	1.35
	205	1154:54 - 1205:00	2.46
	206	1209:52 - 1218:20	2.16
	207	1220:27 - 1242:03	2.58
	208	1248:47 - 1258:36	1.76

MISTT 1976

PARTICULATE SULFUR (Sp) DATA

Date: July 23, 1976

AIRCRAFT	SAMPLE #	SAMPLE TIME	S_p CONCENTRATION ($\mu g/m^3$)
MRI	17.8	0428:57 - 0436:15	1.23
	18.6	0516:05 - 0520:35	1.33
	19.4	0527:50 - 0531:40	1.69
	20.2	0536:30 - 0541:10	2.25
	21.0	0545:50 - 0554:10	2.82
	21.8	0618:30 - 0635:43	1.22
	22.6	0639:35 - 0645:40	2.13
	23.4	0650:10 - 0655:05	2.35
	24.2	0659:55 - 0704:40	3.89
	25.0	0707:40 - 0712:30	2.89
	25.8	0716:55 - 0721:40	2.53
	26.6	0730:25 - 0739:20	0.67
	27.4	0742:00 - 0752:00	1.15
	28.3	0755:30 - 0815:55	1.17
	29.0	1010:00 - 1020:00	1.90
	30.8	1031:40 - 1055:00	3.06
	31.6	1059:00 - 1123:00	3.06
	32.4	1129:35 - 1139:40	2.42
	33.2	1150:00 - 1202:30	2.60
	33.8	1206:25 - 1218:00	1.59
	34.6	1220:20 - 1229:30	3.17
	35.5	1232:00 - 1241:15	2.38
	36.3	1244:45 - 1253:50	3.02
	37.2	1300:00 - 1317:35	4.03

MISTT 1976

PARTICULATE SULFUR (S_p) DATA

Date: July 23, 1976

AIRCRAFT	SAMPLE #	SAMPLE TIME	S_p CONCENTRATION ($\mu g/m^3$)
WU	026	1408:15 - 1421:50	1.79
	27	1427:45 - 1441:20	3.22
	28	1442:16 - 1444:17	0.49
	29	1445:29 - 1501:30	1.06
	31	1509:08 - 1540:01	3.17
	32	1545:06 - 1600:57	2.93
	33	1614:13 - 1625:16	3.79
	34	1634:16 - 1642:16	2.01
	48	1848:43 - 1907:40	1.33
	49	1908:50 - 1933:16	3.13
	50	1936:08 - 2001:00	2.73
	51	2003:50 - 2013:50	2.00
	52	2016:40 - 2021:00	2.93
	53	2023:12 - 2046:10	3.54
	54	2046:49 - 2114:10	2.83
	55	2120:38 - 2143:40	2.44
	56	0540:18 - 0553:00	0.71
	57	0556:21 - 0644:00	2.48
	58	0644:48 - 0057:00	2.02

MISTT 1976

PARTICULATE SULFUR (S_p) DATA

Date: July 23-24, 1976

AIRCRAFT	SAMPLE #	SAMPLE TIME	S_p CONCENTRATION ($\mu g/m^3$)
MRI	1	2321 - 2344	1.74
	2	2344 - 2359	2.06
	3	0006 - 0016 0019 - 0032	1.10
	4	0055 - 0116	0.84
	5	0154 - 0215	1.47
	6	0215 - 0230	2.70
	7	0250 - 0305	1.71
	8	0416 - 0435	2.38
	9	0435 - 0447	2.34
	10	0458 - 0519	0.25
	11	0519 - 0534	0.25
	12	0541 - 0602	0.86
	13	0602 - 0612	2.67
	14	0634 - 0652	2.04
	15	0703 - 0723	4.79
	17	1214 - 1238	0.74
	18	1238 - 1300	2.00
	19	1302 - 1324	1.28
	20	1325 - 1339	1.36
	21	1340 - 1407	1.31

MISTT 1976

PARTICULATE SULFUR (S_p) DATA

Date: July 26, 1976

AIRCRAFT	SAMPLE #	SAMPLE TIME	S_p CONCENTRATION ($\mu g/m^3$)
MRI	68.00	0414:35 - 0430:00	3.86
	68.80	0554:58 - 0658:00	6.03
	69.6	0706:09 - 0715:40	2.16
	70.4	0721:03 - 0800:28	4.65

MISTT 1976

PARTICULATE SULFUR (S_p) DATA

Date: July 27, 1976

AIRCRAFT	SAMPLE #	SAMPLE TIME	S_p CONCENTRATION ($\mu g/m^3$)
MRI	1	1055 - 1108	1.50
	2	1124 - 1202	2.66

MISTT 1976

PARTICULATE SULFUR (S_p) DATA

Date: July 28, 1976

AIRCRAFT	SAMPLE #	SAMPLE TIME	S_p CONCENTRATION ($\mu g/m^3$)
MRI	90.0	0503:20 - 0520:10	1.74
	90.8	0523:30 - 0529:30	4.00
	91.5	0534:00 - 0542:40	1.06
	92.6	0546:30 - 0554:40	1.25
	93.2	0604:30 - 0609:45	3.36
	94.0	0612:00 - 0617:00	2.20
	95.8	0630:30 - 0637:45	1.53
	96.6	0644:45 - 0650:00	2.90
	97.5	0653:20 - 0700:45	2.80
	99.0	0707:40 - 0713:00	1.36
	99.8	0719:00 - 0722:35	1.86
	100.6	0724:00 - 0727:00	2.50
	101.5	0728:30 - 0732:20	1.38
	102.5	0736:20 - 0739:15	0.17
	103.1	0740:35 - 0746:00	0.45
	104.0	1009:25 - 1020:20	1.77
	104.8	1024:30 - 1033:50	1.13
	105.5	1037:30 - 1048:25	1.97
	106.4	1051:00 - 1101:10	1.85
	107.2	1103:30 - 1115:50	2.72
	108.0	1117:25 - 1127:15	1.55
	108.9	1131:00 - 1142:20	1.83
	109.7	1144:10 - 1154:00	1.40
	110.5	1158:10 - 1209:00	1.41
	111.3	1212:00 - 1221:25	1.21
	112.1	1227:00 - 1236:00	1.89
	112.9	1240:15 - 1253:05	0.96
	94.9	0621:35 - 0627:15	2.64

MISTT 1976

PARTICULATE SULFUR (S_p) DATA

Date: July 30, 1984

AIRCRAFT	SAMPLE #	SAMPLE TIME	S_p CONCENTRATION ($\mu g/m^3$)
MRI	1	0520 - 0530	3.36
	2	2544 - 0604	3.65
	3	0607 - 0616	2.06
	4	0620 - 0629	1.77
	5	0632 - 0640	2.08
	6	0648 - 0703	2.29
	7	0717 - 0725	1.31
	8	0735:30 - 0742	1.00
	9	0743:30 - 0751	0.80
	10	0756 - 0804	2.50
	11	0806 - 0816	0.75
	12	0820 - 0835 1/2	1.27
	13	0839 - 0845	2.33
	14	0850 - 0903	0.96
	17	1200 - 1216	2.48
	18	1220 - 1225	1.45
	19	1228:30 - 1242	2.32
	20	1245 - 1252	3.50
	21	1256 - 1301	3.00
	22	1304:30 - 1310	2.36
	23	1312 - 1317	3.14
	24	1323 - 1335	5.24
	25	1344 - 1354	1.40
	26	1405 - 1414	3.33
	27	1417 - 1425:30	4.25
	28	1429:30 - 1438	5.20
	29	1442:30 - 1451:30	2.83
	30	1456:30 - 1509	1.02
	31	1509 - 1517	2.00

MISTT 1976

PARTICULATE SULFUR (S_p) DATA

Date: July 30, 1976

AIRCRAFT	SAMPLE #	SAMPLE TIME	S_p CONCENTRATION ($\mu g/m^3$)
WU	65	1240:20 - 1250:15	3.64
	66	1252:00 - 1307:30	3.81
	67	1309:15 - 1329:30	3.75
	68	1331:00 - 1349:45	2.24
	69	1350:45 - 1401:00	2.49
	70	1401:55 - 1411:30	4.95
	71	1416:00 - 1430:20	5.33
	72	1431:20 - 1439:40	2.16
	73	1443:30 - 1456:40	2.81
	74	1637:45 - 1649:55	5.23
	75	1650:40 - 1658:35	2.97
	76	1700:55 - 1711:00	5.30
	77	1711:55 - 1720:55	3.89
	78	1722:20 - 1732:30	3.35
	79	1733:20 - 1745:25	5.41
	80	1746:15 - 1747:15	85.50 ?
	81	1759:20 - 1812:32	5.83
	82	1813:19 - 1820:55	7.76
	84	1923:25 - 1930:25	7.43
	85	1931:05 - 1946:05	5.27
	86	1947:05 - 1957:05	3.15
	87	1957:50 - 2012:00	3.96
	88	2012:55 - 2023:00	8.32
	89	2024:00 - 2042:00	3.42

MISTT 1976

PARTICULATE SULFUR (S_p) DATA

Date: August 2, 1976

AIRCRAFT	SAMPLE #	SAMPLE TIME	S_p CONCENTRATION ($\mu g/m^3$)
WU	94	1110:20 - 1139:05	0.85
	95	1139:55 - 1207:17	1.17
	96	1208:02 - 1234:55	0.58
	97	1235:35 - 1257:10	0.74
	98	1259:55 - 1303:30	1.39
	99	1440:45 - 1513:10	2.27
	100	1515:20 - 1549:30	1.43
	101	1551:00 - 1621:50	1.51
	103	1623:25 - 1625:50	2.40
	104	1652:45 - 1707:55	0.73
	105	1708:50 - 1747:55	2.17
	106	1841:55 - 1909:25	2.36
	107	1910:25 - 1937:40	2.73
	108	1938:20 - 2003:20	1.12
	109	2004:25 - 2027:37	0.75
	110	2031:10 - 2051:30	0.79

APPENDIX C - VORTACS

INTERPRETATION OF VORSTN (VOR STATION) CODE

	VOR STATION			LOCATION	
Code	Name	Abbreviation	Frequency	Latitude/Longitude	Nearest City
1.	St. Louis	STL	117.4	38°51'30"/90°31'2"	St. Louis, MO
2.	Troy	TOY	116.0	38°44'24"/89°55'0"	Troy, IL
3.	Capitol	CAP	112.7	39°53'30"/89°37'36"	Springfield, IL
4.	Vandalia	VLA	114.3	39° 5'30"/89° 9'36"	Vandalia, IL
5.	Centralia	ENL	115.0	38°25'10"/89° 9'30"	Centralia, IL
6.	Decatur	DEC	110.6	39°44'10"/88°51'24"	Decatur, IL
7.	Mattoon	MTD	109.4	39°28'36"/88°17'24"	Mattoon, IL
8.	Bible Grove	BIB	109.0	38°55'12"/88°28'48"	Effingham, IL
9.	Samsville	SAM	116.6	38°29' 0"/88° 5' 6"	Albion, IL
10.	Farmington	FAM	115.7	37°40'18"/90°14' 0"	Farmington, MO
11.	Marion	MWA	110.4	37°45' 0"/89° 0'30"	Marion, IL
12.	Cape Girardeau	CGI	112.9	37°13'36"/89°33'48"	Cape Girardeau, MO
13.	Quincy	VIN	113.1	39°50'42"/91°16'30"	Quincy, IL
14.	Vichy	VIH	117.7	38° 9' 0"/91°42'12"	Rolla, MO
15.	Jefferson City	JFF	110.2	38°35'30"/92° 9'30"	Jefferson City, MO
16.	Columbia	CBI	117.2	38°58'30"/92°21'48"	Columbia, MO
17.	Hallsville	HLV	114.2	39° 6'48"/92° 7'30"	Centralia, MO
18.	Macon	MCM	112.9	39°39'12"/92"29' 0"	Macon, MO
19.	Foristell	FTZ	110.8	38°41'42"/90°58'12"	New Melle, MO
20.	Robinson	RSV	108.4	39° 1'12"/87°39'12"	Robinson, IL
21.	Bloomington	BMG	110.2	39° 8'36"/86°36'36"	Bloomington, IN
22.	Richmond	RID	110.6	39°45'12"/84°50'12"	Richmond, IN
23.	Lexington	LEX	112.6	37°57'54"/84°28'12"	Lexington, KY
24.	Peoria	PIA	115.2	40°40'54"/89°48'24"	Peoria, IL
25.	Champaign	CMI	110.0	40° 2' 6"/88°16'30"	Champaign, IL
26.	Pontiac	PNT	109.6	40°49'24"/88°43'54"	Pontiac, IL
27.	Roberts	RBS	116.8	40°34'54"/88° 9'36"	Roberts, IL
28.	Cincinnati	CUG	117.3	39° 0'48"/84°42' 0"	Cincinnati, OH
29.	Maples	MAP	113.4	37°35'18"/91°47'12"	Maples, MO
30.	Burlington	BRL	111.4	40°43'24"/90°55' 0"	Burlington, MO
31.	Moline	MZV	114.4	41°19' 0"/90°38' 0"	Rock Island, IL
32.	Evansville	EVV	113.3	37°55'30"/87°45'36"	Evansville, IN
33.	Indianapolis	IND	116.3	39°48'48"/87°22' 0"	Indianapolis, IN
34.	Cunningham	CNG	113.6	37° 0'24"/88°50' 0"	Paducah, KY
35.	Bowling Green	BWG	117.9	36°55'42"/86°26'30"	Bowling Green, KY
36.	Central City	CCT	109.8	37°22'54"/87°15'24"	Central City, KY
37.	Terre Haute	JUF	111.8	39°29'12"/87°14'48"	Terre Haute, IND
38.	Danville	DNV	111.0	40°17'36"/87°33'12"	Danville, IL
39.	NABB (Louisville)	ABB	113.5	38°35'12"/85°38' 0"	Nabb, KY
40.	Louisville	LOU	114.8	38° 6' 0"/85°34'30"	Louisville, KY
41.	Livingston	LVT	108.4	36°35' 6"/85° 9'48"	Byrdstown, TN
42.	London	LOZ	116.1	37° 1'54"/84° 6'30"	London, KY
43.	Kirksville	IRK	114.6	40°08'00"/92°35'30"	Kirksville, MO
44.	Blue Springs	BSP	113.6	39°02'50"/94°15'35"	Kansas City, MO
45.	Falmouth	FLM	117.0	38°38'38"/84°18'40"	Falmouth, KY

MISTT 1975

MRI AIRCRAFT

SUMMARY OF CONTACT WITH VOR STATIONS

DATE	SAMPLING TIME	VOR STATION NAME	VOR STATION FREQUENCY
July 17	0728 - 1325	St. Louis	117.4
July 18	0658 - 0836	St. Louis	117.4
	0836 - 1320	Troy	116.0
	(1220 - 1227)	(Capital)	(112.7)
	1320 - 1433	Vandalia	114.3
	1546 - 1856	Decautur	110.6
July 19	0748 - 0942	Maryland Heights*	110.8
	1327 - 1406	St. Louis	117.4
July 21	0700 - 1240	Maryland Heights*	110.8
July 22	0726 - 1015	Maryland Heights*	110.8
	1015 - 1117	St. Louis	117.4
	1309 - 1333	St. Louis	117.4
	1333 - 1411	Quincy	113.1
July 24	2113 - 0013	Maryland Heights*	110.8
25	0211 - 0435	Vichy	117.7
July 28	1311 - 1624	Maryland Height*	110.8
	1737 - 1808	St. Louis	117.4
July 29	1334 - 1627	St. Louis	117.4
	1627 - 2231	Quincy	113.1
30	0014 - 0300	Quincy	113.1
	0505 - 0627	Peoria	115.2
	0640 - 0729	Macon	112.9
	0729 - 1127	Kirksville	114.6

MISTT 1975

MRI AIRCRAFT

SUMMARY OF CONTACT WITH VOR STATIONS Cont.

DATE	SAMPLING TIME	VOR STATION	
		NAME	FREQUENCY
Aug 06	1656 - 1930	Maryland Heights*	110.8
Aug 7-8	1732 - 2104	Maryland Heights*	110.8
	2257 - 2354	Maryland Heights*	110.8
	2354 - 0113	Columbia	111.2
Aug 8-9	2208 - 0124	Maryland Heights*	110.8
	0124 - 0142	Quincy	113.1
Aug 10	0511 - 0608	Maryland Heights*	110.8
	0608 - 0658	Columbia	111.2
	0658 - 1035	Blue Springs	113.6
	1035 - 1214	Quincy	113.1
	1214 - 1247	Captital	112.7
	1247 - 1325	Decatur	110.6
	1325 - 1353	Indianapolis	116.3
	1530 - 1622	Terre Hauté	111.8
	1622 - 1729	Capital	112.7
	1729 - 1750	St. Louis	117.4
Aug 11	0744 - 0830	Maryland Heights*	110.8
	0830 - 1100	Troy	116.0
	1140 - 1411	Vandalia	114.3
	1411 - 1526	Bible Grove	109.0
	1607 - 1637	Decatur	110.6
	1637 - 1720	Champaign	110.0
	2011 - 2047	Bible Grove	109.0
	2047 - 2134	Troy	116.0
Aug 12	0800 - 0914	Troy	116.0
	0914 - 1106	Centralia	115.0
	1246 - 1511	Bible Grove	109.0
Aug 13	0640 - 0952	Maryland Heights	110.8

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*Maryland Heights VORTAC (1975) since renamed FORISTELL (110.8)

MISTT 1976

MRI AIRCRAFT

SUMMARY OF CONTACT WITH VOR STATIONS

DATE	SAMPLING TIME	NAME	FREQUENCY
July 01	0827 - 1130	Foristell	110.8
July 02	0844 - 0927	Foristell	110.8
	0927 - 1140	Troy	116.0
	1140 - 1241	Foristell	110.8
	1316 - 1642	Vandalia	114.3
July 05	1108 - 1448	Foristell	110.8
	1627 - 1940	Vichy	117.7
	2047 - 2353	Vichy	117.7
July 06	0214 - 0445	Maples	113.4
July 07	0904 - 1120	Centralia	115.0
	1120 - 1227	Troy	116.0
	1430 - 1620	Troy	116.0
	1629 - 1803	Centralia	115.0
July 14	0618 - 1001	St. Louis	117.4
	1130 - 1423	St. Louis	117.4
July 15	0823 - 1030	Foristell	110.8
	1030 - 1146	Troy	116.0
	1349 - 1400	Foristell	110.8
	1400 - 1518	Troy	116.0
July 18	0739 - 0928	St. Louis	117.4
	1456 - 1837	St. Louis	117.4
	2107 - 0031	St. Louis	117.4

MISTT 1976

MRI AIRCRAFT

SUMMARY OF CONTACT WITH VOR STATIONS Cont.

DATE	SAMPLING TIME	VOR STATION NAME	VOR STATION FREQUENCY
July 20	1054 - 1250	Foristell	110.8
	1257 - 1600	Troy	116.0
	1610 - 1923	Vandalia	114.3
	2116 - 2355	Decatur	110.6
	2357 - 0030	Vandalia	114.3
July 23	0429 - 0813	Foristell	110.8
	1010 - 1318	Centralia	115.0
	2020 - 2200	Bible Grove	109.0
	2321 - 0000	Indianapolis	116.3
July 24	0006 - 0032	NAAB (Louisville)	113.5
	0040 - 0116	Bloomington, IND	110.2
	0140 - 0305	Cincinnati	117.3
	0416 - 0612	Cincinnati	117.3
	0634 - 0800	Falmouth, KY	117.0
	1214 - 1300	NAAB (Louisville)	113.5
	1302 - 1339	Bloomington, IND	110.2
	1340 - 1408	Evansville	113.3
July 26	0414 - 0800	Foristell	110.8
July 27	1055 - 1108	Foristell	110.8
	1124 - 1202	St. Louis	117.4
July 28	0411 - 0419	Foristell	110.8
	0503 - 0713	St. Louis	117.4
	1009 - 1253	Foristell	110.8
July 30	0520 - 0845	St. Louis	117.4
	0850 - 0903	Foristell	110.8
	1151 - 1514	Foristell	110.8

APPENDIX D - TAPE AND FILE FORMATS

TAPE AND FILE FORMATS

Tape Format

The GDDB of MISTT is written on three 2400 ft. long, 1/2 inch wide, industry-compatible, 9-track magnetic tapes. The data packing density is 1600 BPI. Blocking within each file is fixed, and the block length is 1600 bytes.* The tapes have no labels or ANSI standard volume and file labels. Each file on a tape is separated by a single end-of-file (EOF) mark, and two end-of-file marks follow the last file on the tape. The data are encoded in ASCII unless otherwise stated.

Tape Contents

There are three tapes in the GDDB of MISTT. Tapes 1 and 2 contain the data of MISTT 1975, and tape 3 contains the data of MISTT 1976. There are a total of 47 files on Tape 1,
a total of 38 files on Tape 2,
and a total of 72 files on Tape 3.

File Formats

All data files in these tapes are in one of only two formats, viz. the STATE-20 and the STATE-VS. Only the Rockwell mobile pibal data are in STATE-VS; the remainder of the data files are all in STATE-20. A detailed documentation of the two file formats follows this section. For each field study (1975 or 1976), all data except those of ANL are grouped by daily missions. Each such daily group of files is preceded by a summary file (FILSyy.mdd) which literally identifies each file in that day's group. These summary files are the only files on the tapes not in the STATE-20 or -VS format.

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*All data files have fixed 1600 byte blocks. The daily summary files (i.e. FILSyy.mdd), however, have a maximum block size of 1600 bytes.

STATE-20 DOCUMENTATION

The STATE-20 data file format has been designed for data of a time-series form, i.e. sequential data records, each consisting of a time and corresponding values of a certain number of measured variables. Most data in the STATE data base, (comprising the GDDBs of MISTT, TPS, PEPE/NEROS, and CWPS) are of this form. Hence, STATE-20 is the most predominant data file format in these GDDBs.

File Format

The entire file is written in fixed 80-character card images (logical records). Each file has the following overall structure:

HEADER SECTION
DATA SECTION
COMMENTS SECTION
EOF (End of File mark)

The *comments section* consists of an arbitrary number of logical records with literal information of an elucidatory nature -- who, what, when, where, why, how, problems, quality assessment, exceptions, definitions, etc. It includes, in particular, definitions of data variables whose names are not self-explanatory. The comments section starts immediately following the data section. No separation markers or records exist. The start of the data section and its length, however, are predefined. The end of the comments is followed by an end-of-file (EOF) marker.

The *data section* contains the actual data of the measured variables, grouped into individual repeated observations. Each observation consists of one set of values of the measured variables (including date and time of the observation). Observations are sequential and chronological, and they all have the same format since the same variables are repeated in each observation. This observation format is a predefined syntactically correct FORTRAN format incorporating several 80-character records in one observation.

The *header section* contains important information which self-documents the file format and contents. It defines the number of variables (NVAR) and the number of 80-character logical records (NREC) in each observation; it identifies the data variables by their assigned names, and gives the specific FORTRAN format of each observation of data; and it gives the averaging time of the observation (i.e. the inter-observation time interval for continuous data) and the overall size of the data section, i.e. the total number of observations (NOBS) in the data section.

The detailed record-by-record documentation of the file is as follows:

Header Records (Logical H1, H2, ...)

H1: Content - NVERSION, NREC, NVAR, FILENAME, DATEC, DELTAT, UNITDT

Column(s) -	1-2	5-6	7-10	13-22	25-32	35-39	41-48
Format -	I2	I2	I2	10A1*	8A1	F5.0	8A1*

(* = left justified)

Definitions -

NVERSION = 20 = current version of this STATE format

NREC = number of 80-character logical records per observation

NVAR = number of variables in one observation

FILENAME = FFFFFF.XXX

FFFFFF = any upto-6-character alphanumeric filename, starting in column 13. Usually, this name has the form OOOOyy, where OOOO is an identifier of organization/platform collecting data, and yy denotes year of data collection. Examples: MRI75, WU76, NASA80, UVDIAL

.XXX = any upto-3-character alphanumeric filename extension. For dated missions, we recommend XXX to provide the date in the form mdd, where m=month (1-9 = Jan-Sept; A,B,C = Oct,Nov,Dec), and dd=day of month (1-31)

DATEC = Date of data collection, preferably in the format mm/dd/yy.

DELTAT = Time interval between successive observations, if fixed (0 for irregular intervals).

UNITDT = Unit of DELTAT (e.g. HOURS, MIN, SEC, etc.)

H2: Content - PROJECT, ORGANIZATION COLLECTING DATA, DATA DESCRIPTION

Format - (30A1, 10A1, 40A1)

H3: Data encoding format in parentheses. The format is assumed to be syntactically correct FORTRAN format with NVAR fields in F or E format (no I-format); use of X for spacing and / for line feed may be used in the format statement. Example for an observation with NVAR = 17 and NREC = 2: (9F8.2, 8X, /, 5F7.1, 3E13.6, 6X)

H(4a, 4b, etc...as needed):
Names of the NVAR data variables, 8 per line, in (8(8A1, 2X)) format.

H(5a, 5b, etc...as needed):
Units of the NVAR variables, 8 per line, in (8(8A1, 2X)) format.

H6: Number of total data observations (NOBS) in file in I10 format.

--- End of Header Section ---

Data Records (Logical D1, D2, ...)

The total number of logical records in this section is NREC*(NOBS+2). The first 2*NREC records contain the physical upper and lower bounds of all data variables. The remaining NREC*NOBS records contain the actual data of the NOBS observations. The data section thus has the following record-by-record form:

D(1 to NREC):
Physical upper bounds of data variable values in specified FORTRAN format for any data observation

D(NREC+1 to 2*NREC):
Physical lower bounds of data variable values in observation format

D(2*NREC + 1 to NREC*[NOBS+2]):
The actual observed data in observation format.

--- End of Data Section ---

Comment Records (Logical C1, C2, ...)

C1 to Last logical record of file:

Arbitrary number of logical records with literal comments containing any useful information concerning the program, the data variables, data quality assessment, references to related reports, people to contact for help, or any other useful message for posterity.

EOF

--- End of File ---

STATE-VS DOCUMENTATION

The STATE-VS format has been designed as a complement to the currently existing STATE-20 format. STATE-20 is appropriate for time-series type data, while STATE-VS is appropriate for vertical soundings type data, e.g. pibal, radiosonde, sodar, etc.

File Format

Each file normally contains the data of all vertical soundings of a given platform (or station) for a given day. The filename has the form nnnnnn.mdd, nnnnnn= any I.D. of file (e.g. organization,
type of data, etc.), and
mdd = month, day (e.g. 724=July 24)
= date of data collection
(A=October, B=November, C=December)

The overall file format is as follows:

```
FILE HEADER RECORDS

&&
-----------------------------------------------------------
                              { subfile header records
SUBFILE 1                     { subfile data records
(for first sounding)          { subfile comment records

@@
-----------------------------------------------------------
                              { subfile header records
SUBFILE 2                     { subfile data records
(second sounding)             { subfile comment records

@@
-----------------------------------------------------------
    :
 SUBFILE n
    :
@@
-----------------------------------------------------------
&&

FILE COMMENT RECORDS
-----------------------------------------------------------
EOF
```

The main file header defines such specific items common to all soundings in the file as Project, Organization Collecting Data, Type of Data, Filename, Reported Data Parameters, their Units, Range, etc., Data Record Format and Size, etc. If the data are of vertical soundings, the first parameter should be the height level (altitude).

The main file comments provide any additional information common to the total data set which is judged useful, but which cannot be included in the main file header.

Each subfile contains the information pertinent to a single sounding. Subfiles must be arranged in chronological order. The subfile header specifically defines the time and location of the sounding and the number of records (height levels for a vertical sounding) in the subfile. Each data record provides a height level and the corresponding data of the measured parameters (e.g. wind speed, wind direction). The subfile is concluded by any comment records specific to this sounding.

Logical record size is fixed at 80 characters.

(a) Main File Header

The main file header defines specific minimum file information in a specific format. In the following header format description, underlined character strings are to be fixed, as indicated, and the rest of the information is variable.

Record 1: FORMAT: STATE-VS

Record 2: PHYSICAL RECORD: 80 BYTES, LOGICAL RECORD: 80 BYTES

Record 3: PROJECT: (T10,71A1)

Record 4: ORGANIZATION: (T15,66A1)

Record 5: TYPE OF DATA: (T15,66A1)

Record 6: FILENAME: (T11,nnnnnn.mdd) DATE OF DATA COLLECTION: MM/DD/YY

Record 7: DELTA T: VALUE =(T20,I3) UNITS CODE = (T39,I2)

This record provides information about time interval between soundings.

UNITS CODE = 0 indicates interval is irregular
= 1 indicates interval is in seconds
= 2 indicates interval is in minutes
= 3 indicates interval is in hours

(e.g. 3-hourly soundings defined by value = 3, code = 3).

Record 8: NO. OF PARAMETERS PER RECORD: (T30,I4)

Record 9: DATA RECORD FORMAT: (Data encoding format in parenthesis) Open parenthesis to be placed in column 21. The encoding format is assumed to contain a syntactically correct FORTRAN format specification utilizing only F, E and X format codes (no I-format please!) and "read record" slashes, suitable for decoding the data. Example: (F6.0, 2E12.4, 2F5.0, 40X)

Record 10: PARAMETER NAMES

Record 11: Logical record 11 should contain the parameter names in the format: n(8A1, 2X), n=number of parameters

Record 12: PARAMETER UNITS

Record 13: Logical record 13 should contain the parameter units in the format: n(8A1,2X), n=number of parameters.

Record 14: DATA MINIMA

Record 15: The actual or possible minimum values of the parameters in data record format

Record 16: DATA MAXIMA

The actual or possible maximum values of the parameters in data record format

Record 17: PLOT MINIMA

Record 18: Suggested lower bound values of the parameters to be used for general plotting purposes

Record 19: PLOT MAXIMA

Record 20: Suggested upper bound values of the parameters to be used for general plotting purposes.

N.B. Data min/max range should include range of valid data values, including outlier (but valid) values.

Plot min/max range would normally include normal data values (and possibly not include valid outliers).

Record 21: NO. OF SUBFILES: (T19,I3)

Record 22: && (end of Main File Header)

(b) Subfile Header

Record 1: SUBFILE (T8,I3) Sequential subfile number

Record 2: LOCATION OF OBSERVATION

Record 3: NAME: (T26,55A1) Literal name of location, if any.

Record 4: INITIAL POSITION: (T26,E14.7,2X,E14.7,2X,E14.7)
LAT LONG ELEV(m MSL)

Record 5: FINAL POSITION: (T26,E14.7,2X,E14.7,2X,E14.7)
LAT LONG ELEV

For stationary platforms (e.g. PIBAL during a single sounding), initial and final positions will be same. For a moving platform, such as an aircraft lidar making a remote vertical profile sounding, the subfile may contain an average profile measured between aircraft initial and final positions during averaging time.

Record 6: TIME OF OBSERVATION

Record 7: DATE: (T26, MM/DD/YY)

Record 8: TIME: (T28, HHMMSS)

Record 9: NO. OF SUBFILE DATA RECORDS: (T29,I10)

Record 10: Start of data records (in specified data record format)

⋮

N data records

⋮

Record 10 + N: Start of comment records (80A1 format)

@@ (End of subfile)

APPENDIX E - DAILY DATA BASE SUMMARY FILES

DAILY SUMMARY FILES

All data files on each tape, except the ANL files, are grouped by daily missions. The group of data files of each mission is preceded by a summary file (called FILSyy.mdd, where yymdd denotes the starting date of the mission). Each summary file merely identifies the actual files in that group. Each entry contains the filename, identification of type of data on the file and the file format (STATE-20 or STATE-VS). Of course, all filenames in each daily group must have the same yy.mdd. In this section, we list the entire contents of every summary file in the entire GDDB of MISTT. The list therefore identifies all files in the GDDB except the two ANL files which are the last files in the data base of each year.

CONTENTS OF DAILY SUMMARY FILES IN TAPE 1 (JULY 1975)

FILS75.717	LIST OF FILES FOR 7/17/75	
EMI75.717	MISTT COSPEC AIRCRAFT DATA	STATE-20
MRI75S.717	MRI AIRCRAFT DATA - SPIRALS	STATE-20
MRI75T.717	MRI AIRCRAFT DATA - TRAVERSES	STATE-20
PI75.717	SINGLE-THEODOLITE PIBAL WIND PROFILE	STATE-VS
FILS75.718	LIST OF FILES FOR 7/18/75	
EMI75.718	MISTT COSPEC AIRCRAFT DATA	STATE-20
MRI75S.718	MRI AIRCRAFT DATA - SPIRALS	STATE-20
MRI75T.718	MRI AIRCRAFT DATA - TRAVERSES	STATE-20
PI75.718	SINGLE-THEODOLITE PIBAL WIND PROFILE	STATE-VS
FILS75.719	LIST OF FILES FOR 7/19/75	
EMI75.719	MISTT COPSEC AIRCRAFT DATA	STATE-20
MRI75S.719	MRI AIRCRAFT DATA - SPIRALS	STATE-20
MRI75T.719	MRI AIRCRAFT DATA - TRAVERSES	STATE-20
PI75.719	SINGLE-THEODOLITE PIBAL WIND PROFILE	STATE-VS
FILS75.721	LIST OF FILES FOR 7/21/75	
MRI75S.721	MRI AIRCRAFT DATA - SPIRALS	STATE-20
MRI75T.721	MRI AIRCRAFT DATA - TRAVERSES	STATE-20
PI75.721	SINGLE-THEODOLITE PIBAL WIND PROFILE	STATE-VS
FILS75.722	LIST OF FILES FOR 7/22/75	
MRI75S.722	MRI AIRCRAFT DATA - SPIRALS	STATE-20
MRI75T.722	MRI AIRCRAFT DATA - TRAVERSES	STATE-20
PI75.722	SINGLE-THEODOLITE PIBAL WIND PROFILE	STATE-VS
FILS75.724	LIST OF FILES FOR 7/24/75	
EMI75.724	MISTT COSPEC AIRCRAFT DATA	STATE-20
MRI75S.724	MRI AIRCRAFT DATA - SPIRALS	STATE-20
MRI75T.724	MRI AIRCRAFT DATA - TRAVERSES	STATE-20
PI75.724	SINGLE-THEODOLIT PIBAL WIND PROFILE	STATE-VS
FILS75.725	LIST OF FILES FOR 7/25/75	
EMI75.725	MISTT COSPEC AIRCRAFT DATA	STATE-20
MRI75S.725	MRI AIRCRAFT DATA - SPIRALS	STATE-20
MRI75T.725	MRI AIRCRAFT DATA - TRAVERSES	STATE-20
FILS75.726	LIST OF FILES FOR 7/26/75	
EMI75.726	MISTT COSPEC AIRCRAFT DATA	STATE-20
MRI75S.726	MRI AIRCRAFT DATA - SPIRALS	STATE-20
FILS75.728	LIST OF FILES FOR 7/28/75	
EMI751.728	MISTT COSPEC AIRCRAFT DATA	STATE-20
EMI752.728	MISTT COSPEC AIRCRAFT DATA	STATE-20
MRI75S.728	MRI AIRCRAFT DATA - SPIRALS	STATE-20
MRI75T.728	MRI AIRCRAFT DATA - TRAVERSES	STATE-20
FILS75.729	LIST OF FILES FOR 7/29/75	
EMI751.729	MISTT COSPEC AIRCRAFT DATA	STATE-20
EMI752.729	MISTT COSPEC AIRCRAFT DATA	STATE-20
MRI75.729	MRI AIRCRAFT DATA - SPIRAL & TRAVERSES	STATE-20
PI75.729	SINGLE-THEODOLITE PIBAL WIND PROFILE	STATE-VS
FILS75.730	LIST OF FILES FOR 7/30/75	
PI75.730	SINGLE-THEODOLITE PIBAL WIND PROFILE	STATE-VS

APPENDIX F - SAMPLE LISTINGS OF CONTENTS OF DATA FILES

CONTENTS OF DAILY SUMMARY FILES IN TAPE 2 (AUG. 1975)

FILS75.801	LIST OF FILES FOR 8/01/75	
EMI75.801	MISTT COSPEC AIRCRAFT DATA	STATE-20
FILS75.803	LIST OF FILES FOR 8/03/75	
EMI75.803	MISTT COSPEC AIRCRAFT DATA	STATE-20
FILS75.804	LIST OF FILES FOR 8/04/75	
EMI75.804	MISTT COSPEC AIRCRAFT DATA	STATE-20
PI75.804	SINGLE-THEODOLITE PIBAL WIND PROFILE	STATE-VS
FILS75.805	LIST OF FILES FOR 8/05/75	
EMI75.805	MISTT COSPEC AIRCRAFT DATA	STATE-20
PI75.805	SINGLE-THEODOLITE PIBAL WIND PROFILE	STATE-VS
FILS75.806	LIST OF FILES FOR 8/06/75	
EMI75.806	MISTT COSPEC AIRCRAFT DATA	STATE-20
MRI75.806	MRI AIRCRAFT DATA - SPIRALS & TRAVERSES	STATE-20
FILS75.807	LIST OF FILES FOR 8/07/75	
EMI751.807	MISTT COSPEC AIRCRAFT DATA	STATE-20
EMI752.807	MISTT COSPEC AIRCRAFT DATA	STATE-20
MRI75.807	MRI AIRCRAFT DATA - SPIRALS & TRAVERSES	STATE-20
FILS75.808	LIST OF FILES FOR 8/08/75	
MRI75S.808	MRI AIRCRAFT DATA - SPIRALS	STATE-20
MRI75T.808	MRI AIRCRAFT DATA - TRAVERSES	STATE-20
FILS75.809	LIST OF FILES FOR 8/09/75	
EMI75.809	MISTT COSPEC AIRCRAFT DATA	STATE-20
FILS75.810	LIST OF FILES FOR 8/10/75	
EMI75.810	MISTT COSPEC AIRCRAFT DATA	STATE-20
MRI75S.810	MRI AIRCRAFT DATA - SPIRALS	STATE-20
MRI75T.810	MRI AIRCRAFT DATA - TRAVERSES	STATE-20
FILS75.811	LIST OF FILES FOR 8/11/75	
MRI75S.811	MRI AIRCRAFT DATA - SPIRALS	STATE-20
MRI75T.811	MRI AIRCRAFT DATA - TRAVERSES	STATE-20
PI75.811	SINGLE-THEODOLITE PIBAL WIND PROFILE	STATE-VS
FILS75.812	LIST OF FILES FOR 8/12/75	
EMI75.812	MISTT COSPEC AIRCRAFT DATA	STATE-20
MRI75S.812	MRI AIRCRAFT DATA - SPIRALS	STATE-20
MRI75T.812	MRI AIRCRAFT DATA - TRAVERSES	STATE-20
FILS75.813	LIST OF FILES FOR 8/13/75	
MRI75S.813	MRI AIRCRAFT DATA - SPIRALS	STATE-20
MRI75T.813	MRI AIRCRAFT DATA - TRAVERSES	STATE-20

The last file (NO. 38) on this Tape 2 of GDDB-MISTT is ANL75, which contains the ANL data for the entire 1975 field study period.

CONTENTS OF DAILY SUMMARY FILES IN TAPE 3 (1976)

FILS76.627	LIST OF FILES FOR 6/27/76	
WU76.627	WU AIRCRAFT DATA	STATE-20
FILS76.629	LIST OF FILES FOR 6/29/76	
PI76.629	SINGLE-THEODOLITE PIBAL WIND PROFILE	STATE-VS
FILS76.630	LIST OF FILES FOR 6/30/76	
PI76.630	SINGLE-THEODOLITE PIBAL WIND PROFILE	STATE-VS
FILS76.701	LIST OF FILES FOR 7/01/76	
MRI76.701	MRI CONTINUOUS AIRCRAFT DATA	STATE-20
PI76.701	SINGLE-THEODOLITE PIBAL WIND PROFILE	STATE-VS
FILS76.702	LIST OF FILES FOR 7/02/76	
MRI76.702	MRI CONTINUOUS AIRCRAFT DATA	STATE-20
PI76.702	SINGLE-THEODOLITE PIBAL WIND PROFILE	STATE-VS
FILS76.705	LIST OF FILES FOR 7/05/76	
MRI76.705	MRI CONTINUOUS AIRCRAFT DATA	STATE-20
PI76.705	SINGLE-THEODOLITE PIBAL WIND PROFILE	STATE-VS
WU76.705	WU AIRCRAFT DATA	STATE-20
FILS76.706	LIST OF FILES FOR 7/06/76	
PI76.706	SINGLE-THEODOLITE PIBAL WIND PROFILE	STATE-VS
FILS76.707	LIST OF FILES FOR 7/07/76	
MRI76.707	MRI CONTINUOUS AIRCRAFT DATA	STATE-20
PI76.707	SINGLE-THEODOLITE PIBAL WIND PROFILE	STATE-VS
WU76.707	WU AIRCRAFT DATA	STATE-20
FILS76.709	LIST OF FILES FOR 7/09/76	
PI76.709	SINGLE-THEODOLITE PIBAL WIND PROFILE	STATE-VS
WU76.709	WU AIRCRAFT DATA	STATE-20
FILS76.712	LIST OF FILES FOR 7/12/76	
MRI76.712	MRI CONTINUOUS AIRCRAFT DATA	STATE-20
PI76.712	SINGLE-THEODOLITE PIBAL WIND PROFILE	STATE-VS
WU76.712	WU AIRCRAFT DATA	STATE-20
FILS76.713	LIST OF FILES FOR 7/13/76	
WU76.713	WU AIRCRAFT DATA	STATE-20
FILS76.714	LIST OF FILES FOR 7/14/76	
EMI76.714	MISTT COSPEC AIRCRAFT DATA	STATE-20
MRI76.714	MRI CONTINUOUS AIRCRAFT DATA	STATE-20
PI76.714	SINGLE-THEODOLITE PIBAL WIND PROFILE	STATE-VS
WU76.714	WU AIRCRAFT DATA	STATE-20

```
FILS76.715      LIST OF FILES FOR 7/15/76
MRI76.715       MRI CONTINOUS AIRCRAFT DATA
PI76.715        SINGLE-THEODOLITE PIBAL WIND PROFILE     STATE-20
WU76.715        WU AIRCRAFT DATA                         STATE-VS
                                                         STATE-20

FILS76.718      LIST OF FILES FOR 7/18/76
EMI76.718       MISTT COSPEC AIRCRAFT DATA
MRI76.718       MRI CONTINUOUS AIRCRAFT DATA             STATE-20
PI76.718        SINGLE-THEODOLITE PIBAL WIND PROFILE     STATE-20
WU76.718        WU AIRCRAFT DATA                         STATE-VS
                                                         STATE-20

FILS76.720      LIST OF FILES FOR 7/20/76
MRI76.720       MRI CONTINUOUS AIRCRAFT DATA
PI76.720        SINGLE-THEODOLITE PIBAL WIND PROFILE     STATE-20
WU76.720        WU AIRCRAFT DATA                         STATE-VS
                                                         STATE-20

FILS76.723      LIST OF FILES FOR 7/23/76
EMI76.723       MISTT COSPEC AIRCRAFT DATA
MRI76.723       MRI CONTINUOUS AIRCRAFT DATA             STATE-20
PI76.723        SINGLE-THEODOLITE PIBAL WIND PROFILE     STATE-20
WU76.723        WU AIRCRAFT DATA                         STATE-VS
                                                         STATE-20

FILS76.726      LIST OF FILES FOR 7/26/76
MRI76.726       MRI CONTINUOUS AIRCRAFT DATA
PI76.726        SINGLE-THEODOLITE PIBAL WIND PROFILE     STATE-20
                                                         STATE-VS

FILS76.727      LIST OF FILES FOR 7/27/76
MRI76.727       MRI CONTINUOUS AIRCRAFT DATA
                                                         STATE-20

FILS76.728      LIST OF FILES FOR 7/28/76
EMI76.728       MISTT COSPEC AIRCRAFT DATA
MRI76.728       MRI CONTINUOUS AIRCRAFT DATA             STATE-20
PI76.728        SINGLE-THEODOLITE PIBAL WIND PROFILE     STATE-20
                                                         STATE-VS

FILS76.730      LIST OF FILES FOR 7/30/76
MRI76.730       MRI CONTINUOUS AIRCRAFT DATA
PI76.730        SINGLE-THEODOLITE PIBAL WIND PROFILE     STATE-20
WU76.730        WU AIRCRAFT DATA                         STATE-VS
                                                         STATE-20

FILS76.802      LIST OF FILES FOR 8/02/76
WU76.802        WU AIRCRAFT DATA
                                                         STATE-20

FILS76.803      LIST OF FILES FOR 8/03/76
WU76.803        WU AIRCRAFT DATA
                                                         STATE-20
```

The last file (NO. 72) on this Tape 3 of GDDB-MISTT is ANL76, which contains the ANL data for the entire 1976 field study period.

SAMPLE LISTING OF CONTENTS OF DATA FILES

In this section, we give the user a peek into a sample data file corresponding to each measurement platform for which the data are included in GDDB/MISTT. For each sample file, the entire header section, a few data records at the beginning and end of the file, and the comments section are listed exactly as they appear in the file. The files chosen include the following:

an MRI aircraft file of 7/18/76 in STATE-20
a WU aircraft file of 7/18/76 in STATE-20
an EMI aircraft file of 7/18/76 in STATE-20
a Rockwell pibal file of 7/18/76 in STATE-VS
an EMI AQML file of 7/18/75 in STATE-20
and the ANL file of 1976 in STATE-20.

Observe that the header sections identify all parameters (and their units and ranges) in the file and the FORTRAN format of the data records, while the comments sections define parameter names which are not self-explanatory. These leading and trailing sections thus provide a self-documentation of the file. All file physical records are fixed 80-characters in length. A single observation of all parameters is defined as a logical record. One logical record thus consists of one or more physical records, depending on the number of measured parameters. The number of physical records in a logical record is also identified in the file header, as also is the time interval between observations.

25 RECORDS AT BEGINNING OF FILE

HEADER

```
20    3  17  MRI76.718      7/18/76      9. SECONDS
HISTT 1976                         MRI         Continous aircraft data
(GE13.6)
DATE          TIME         EVENT        ALTITUDE     VOR          DME          TEMP         DEW PT
TURB          SO2          NO           NOX          OZONE        CNC          CHARGE       BSCAT
SP
YYMMDD        HHMMSS       CODE         m MSL        DEG-CWN      KM           DEG C        DEG C
R    Unit     PPB          PPB          PPB          PPB          10^3/cc      mV           10^-4/m
UG/M^3
      2121
```

DATA

```
 0.760718E+06 0.235959E+06 0.100000E+02 0.300000E+04 0.360000E+03 0.200000E+03
 0.400000E+02 0.250000E+02 0.100000E+02 0.100000E+04 0.500000E+03 0.500000E+03
 0.500000E+03 0.100000E+03 0.100000E+04 0.100000E+02 0.250000E+02
 0.760718E+06 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00
 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00
 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00
 0.760718E+06 0.928090E+05 0.000000E+00 0.621792E+03 0.336960E+03 0.214508E+03
 0.193000E+02 0.900000E+01 0.106000E+01 0.360000E+02 0.150000E+02 0.130000E+02
 0.580000E+02 0.143000E+02 0.000000E+00 0.869000E+00 0.000000E+00
 0.760718E+06 0.739040E+05 0.200000E+01 0.774192E+03 0.224640E+03 0.463300E+00
 0.183000E+02 0.840000E+01 0.600000E+00 0.900000E+02 0.140000E+02 0.300000E+02
 0.460000E+02 0.245000E+02 0.000000E+00 0.760000E+00 0.000000E+00
 0.760718E+06 0.739120E+05 0.200000E+01 0.774192E+03 0.224640E+03 0.926600E+00
 0.183000E+02 0.840000E+01 0.560000E+00 0.920000E+02 0.150000E+02 0.300000E+02
 0.460000E+02 0.327000E+02 0.000000E+00 0.740000E+00 0.000000E+00
```

25 RECORDS AT END OF FILE

```
 0.347500E+03 0.890000E+01 0.000000E+00 0.628000E+01 0.120000E+00
 0.760718E+06 0.256046E+06 0.000000E+00 0.125578E+04 0.309600E+03 0.926600E+00
-0.120000E+01-0.500000E+02 0.000000E+00 0.340000E+02 0.720000E+02 0.233000E+03
 0.398000E+03 0.132000E+02 0.000000E+00 0.628000E+01 0.200000E+00
 0.760718E+06 0.256046E+06 0.000000E+00 0.125578E+04 0.315360E+03 0.926600E+00
-0.900000E+00-0.500000E+02 0.000000E+00 0.340000E+02 0.730000E+02 0.233000E+03
 0.120000E+03 0.520000E+01 0.000000E+00 0.628000E+01 0.720000E+00
 0.760713E+06 0.255047E+06 0.000000E+00 0.125578E+04 0.321840E+03 0.926600E+00
-0.110000E+01-0.500000E+02 0.000000E+00 0.360000E+02 0.740000E+02 0.233000E+03
 0.360000E+02 0.210000E+01 0.000000E+00 0.628000E+01 0.940000E+00
```

COMMENTS

1. The original data logging was approximately 1 sec interval. These data represent the average of 10 original records (or about 8-9 sec).
2. EVENT CODE:
   0 = NO EVENT, 1 = SPIRAL, 2 = TRAVERSE
3. VOR/DME are aircraft position parameters. VOR is azimuth angle measured clockwise from north (CWN) and DME is radial distance, both with respect to the current VORTAC station. Information about current VORTAC stations is tabulated in Appendix II-VORTACs in the accompanying documentation.
4. TURB = EPSILON^1/3, where EPSILON is the turbulent kinetic energy dissipation rate, thus a measure of small-scale turbulence. The R-unit is ((cm/s)**2s**-1)^1/3 or (cm^2/3)/s.
5. CNC = condensation nuclei count.
6. CHARGE = aerosol charge acceptance.
7. SP = average concentration of particulate sulfur over the integerated time of a filter sample analysed by the flash vaporization/FPD technique.

TOTAL OF 6394 RECORDS IN FILE MRI76S20.718

```
 25 RECORDS AT BEGINNING OF FILE

20    2   13  WU76.718     07/18/76      9.  SECONDS
MISTT 1976                    WU             WU AIRCRAFT DATA
(3F10.1,7,5F10.2,30X)
DATE        TIME        EVENT       VORSTN      VOR         DME          ALTITUDE   SO2
OZONE       CNC         CHARGE      BSCAT       SP
YYMMDD      HHMMSS      CODE        CODE        DEG-CWN     KM           m MSL      PPB
PPB         10^3/CC     mV          10^-4/m     ug/m3
      2636
  760718.0   235959.0         8.0        50.0       360.0      231.6      3000.0      1000.0
    500.00     100.00     1000.00       10.00       25.00
  760718.0        0.0         0.0         0.0         0.0        0.0         0.0         0.0
      0.00       0.00        0.00        0.00        0.00
  760718.0   140627.0         0.0        19.0        77.0        7.4       566.0         8.2
      0.00       0.00       42.00        0.84        0.00
  760718.0   140659.0         0.0        19.0        74.0        7.4       566.0        13.8
      0.00       0.00       48.00        0.88        0.00
  760718.0   140710.0         0.0        19.0        73.0        6.9       536.0        16.8
      0.00       0.00       38.00        0.92        0.00
  760718.0   140729.0         0.0        19.0        72.0        6.9       536.0        18.6
      0.00       0.00       48.00        1.02        0.00
  760718.0   140744.0         0.0        19.0        70.0        6.5       560.0        22.6
      0.00       0.00       58.00        1.04        0.00
  760718.0   140803.0         0.0        19.0        68.0        6.5       542.0        28.6
      0.00       0.00       54.00        1.00        0.00
  760718.0   140816.0         0.0        19.0        66.0        6.0       542.0        32.0

 25 RECORDS AT END OF FILE

      0.00       0.00       40.00        2.32        0.00
  760719.0    23833.0         0.0        19.0        90.0       23.2       530.0        13.0
      0.00       0.00       40.00        2.26        0.00
  760719.0    23844.0         0.0        19.0        92.0       22.7       530.0        13.0
      0.00       0.00       36.00        2.06        0.00
  760719.0    23852.0         0.0        19.0       108.0       22.7       512.0        13.0
      0.00       0.00       38.00        2.09        0.00
  760719.0    23901.0         0.0        19.0        92.0       22.7       499.0        13.0
      0.00       0.00       36.00        2.10        0.00
```

1. Events code identifies type of event, as follows:
   - 0 = No Event
   - 1 = Spiral
   - 2 = Traverse
   - 3 = Dolphin dive
   - 4 = Background
   - 5 = Instrument Zero
   - 8 = Ferry
2. VORSTIN code (1-50) current VOR station. Code interpretation is tabulated in Appendix II- VORTACs in accompanying documentation.
3. VOR/DME azimuth angle (CWN=clockwise from North) and distance of aircraft location from VOR station.
4. CNC=Condensation (Aitken) Nuclei Count.
5. Charge= Signal proportional to aerosol charge acceptance.
6. SP = average concentration of particulate Sulfur during integrated time of aerosol filter sample.

TOTAL OF 5300 RECORDS IN FILE WU76S20.718

```
25 RECORDS AT BEGINNING OF FILE

20    1    9  EMI76.718   07/18/76      3. SECONDS
MISTT 1976                         EMI         MISTT COSPEC AIRCRAFT DATA
(6F10.1,F6.0,2F7.2)
DATE        TIME        UTM-X       UTM-Y       ALTITUDE  C-SO2      EVENT      LAT.
LONG.
YYMMDD      HHMMSS                              m-MSL     PPMM       #          Deg.
Deg.
    1648
  760718.0   170937.0   708039.0 4797671.0      762.0       252.0   16.   43.31   92.33
  760718.0   124545.0   560207.0 4285398.0      365.8         0.0    2.   38.69   89.44
  760718.0   124545.0   683143.0 4285398.0      365.8         6.0    2.   38.69   90.91
  760718.0   124548.0   683284.0 4285411.0      365.8         1.0    2.   38.69   90.90
  760718.0   124551.0   683425.0 4285424.0      365.8         9.0    2.   38.69   90.90
  760718.0   124554.0   683566.0 4285436.0      365.8        20.0    2.   38.69   90.90
  760718.0   124557.0   683707.0 4285449.0      365.8        19.0    2.   38.69   90.90
  760718.0   124600.0   683848.0 4285461.0      365.8        52.0    2.   38.69   90.90
  760718.0   124603.0   683989.0 4285474.0      365.8        55.0    2.   38.69   90.90
  760718.0   124606.0   684130.0 4285487.0      365.8        75.0    2.   38.69   90.89
  760718.0   124609.0   684271.0 4285499.0      365.8       103.0    2.   38.69   90.89
  760718.0   124612.0   684412.0 4285512.0      365.8       128.0    2.   38.69   90.89
  760718.0   124615.0   684553.0 4285524.0      365.8       147.0    2.   38.69   90.89
  760718.0   124618.0   684694.0 4285537.0      365.8       153.0    2.   38.69   90.89
  760718.0   124621.0   684835.0 4285549.0      365.8       151.0    2.   38.69   90.89
  760718.0   124624.0   684976.0 4285562.0      365.8       128.0    2.   38.69   90.88
  760718.0   124627.0   685117.0 4285575.0      365.8       118.0    2.   38.69   90.88

25 RECORDS AT END OF FILE

  760718.0   170837.0   676613.0 4293110.0      457.2        57.0   16.   38.76   90.98
  760718.0   170840.0   676488.0 4293035.0      457.2        50.0   16.   38.76   90.98
  760718.0   170843.0   676362.0 4292959.0      457.2        41.0   16.   38.76   90.98
  760718.0   170846,0   676237.0 4292884.0      457.2        40.0   16.   38.75   90.99
  760718.0   170849.0   676112.0 4292809.0      457.2        33.0   16.   38.75   90.99
  760718.0   170852.0   675961.0 4292718.0      457.2        33.0   16.   38.75   90.99
  760718.0   170855.0   675861.0 4292658.0      457.2        32.0   16.   38.75   90.99
  760718.0   170858.0   675736.0 4292583.0      457.2        39.0   15.   38.75   90.99
  760718.0   170901.0   675611.0 4292508.0      457.2        39.0   16.   38.75   90.99
  760718.0   170904.0   675460.0 4292417.0      457.2        35.0   16.   38.75   90.99
  760718.0   170907.0   675360.0 4292357.0      457.2        27.0   16.   38.75   91.00
  760718.0   170910.0   675210.0 4292267.0      457.2        27.0   16.   38.75   91.00
  760718.0   170913.0   675109.0 4292206.0      457.2        27.0   16.   38.75   91.00
  760718.0   170916.0   674959.0 4292116.0      457.2        27.0   16.   38.75   91.00
  760718.0   170919.0   674859.0 4292056.0      457.2        27.0   16.   38.75   91.00
  760718.0   170922.0   674708.0 4291965.0      457.2        27.0   16.   38.75   91.00
  760718.0   170925.0   674608.0 4291905.0      457.2        27.0   16.   38.75   91.00
  760718.0   170928.0   674483.0 4291830.0      457.2        27.0   16.   38.75   91.01
  760718.0   170931.0   674358.0 4291754.0      457.2        27.0   16.   38.75   91.01
  760718.0   170934.0   674207.0 4291664.0      457.2        26.0   16.   38.74   91.01
  760718.0   170937.0   674107.0 4291604.0      457.2        14.0   16.   38.74   91.01
COMMENTS:                                       457.2         6.0   16.   38.74   91.01
(1) COSPEC-SO2 REPRESENTS VERTICALLY INTEGRATED BURDEN OF SO2 ABOVE THE
    AIRCRAFT FLIGHT ALTITUDE. THE COSPEC VIEWER WAS AIMED UPWARD.
(2) THE UTM X-Y DATA ARE REFERRED TO UTM ZONE 15.

TOTAL OF 1662 RECORDS IN FILE EMI76.718
```

40 RECORDS AT BEGINNING OF FILE

```
FORMAT: STATE-VS
PHYSICAL RECORD: 80 BYTES    LOGICAL RECORD: 80 BYTES
PROJECT: MISTT
ORGANIZATION: ROCKWELL INTERNATIONAL
TYPE OF DATA: SINGLE-THEODOLITE PIBAL WIND PROFILE
FILENAME: PI76.718        DATE OF DATA COLLECTION: 07/18/76
DELTA T:     VALUE =  0     UNITS CODE = 0
NO. OF PARAMETERS PER RECORD:    3
DATA RECORD FORMAT: (3F10.1,50X)
PARAMETER NAMES:
ALTITUDE  WS         WD
PARAMETER UNITS:
m AGL      m/s        Deg. CWN
DATA MINIMA
      0.0         0.0         0.0
DATA MAXIMA
   3000.0        30.0       360.0
PLOT MINIMA
      0.0         0.0         0.0
PLOT MAXIMA
   3000.0        20.0       360.0
NO. OF SUBFILES:   43
&&END OF MAIN HEADER
SUBFILE  1
LOCATION OF OBSERVATION
                    NAME: I-44 AT FENTON, MO.
        INITIAL POSITION:
          FINAL POSITION:
TIME OF OBSERVATION
                    DATE:  7/18/76
                    TIME:    910
NO. OF SUBFILE DATA RECORDS:          20
     76.0         1.4       168.9
    151.0         1.9       157.3
    225.0         2.6       181.3
    297.0         4.1       200.8
    368.0         3.9       201.4
    438.0         3.0       209.3
    506.0         2.7       215.9
    574.0         1.8       218.4
```

10 RECORDS AT END OF FILE

```
    806.0        18.3       183.5
    899.0        13.3       187.5
    990.0        12.2       192.3
   1080.0        10.6       198.5
   1170.0         9.8       206.6
   1260.0         9.3       218.0
   1350.0        -1.0       225.3
OTHER INFORMATION RELEVANT TO SUBFILE 43
@@END OF SUBFILE 43
&&
```

TOTAL OF 1332 RECORDS IN FILE PI76VS.718

```
 25 RECORDS AT BEGINNING OF FILE

20    2  12  EMI75.718      7/18/75      7. SECONDS
MISTT 1975                          EMI        AQML DATA
(6E13.6,2X)
DATE        TIME        UTM-X       UTM-Y       C-SO2       C-NO2       TOT-S       NOX
CHARGE      BSCAT       DELTA-D     DELTA-T
YYMMDD      HHMMSS                              PPMM        PPMM        PPM         PPM
VOLTS       10^-4/M     METERS      SEC
     3132
 0.750718E+06 0.141634E+08 0.822482E+08 0.822482E+08 0.251840E+05 0.246620E+05
 0.164800E+02 0.164480E+02 0.164480E+02 0.164480E+03 0.999900E+04 0.822400E+04
 0.750718E+06 0.000000E+00 0.000000E+00 0.000000E+00-0.150000E+03-0.194000E+03
 0.000000E+00-0.600000E-02 0.000000E+00 0.000000E+00-0.800000E+03 0.000000E+00
 0.750718E+06 0.141634E+08 0.822482E+08 0.822482E+08 0.251840E+05 0.246620E+05
 0.164800E+02 0.164480E+02 0.164480E+02 0.164480E+03 0.822400E+04 0.822400E+04
 0.750718E+06 0.854040E+05 0.721997E+06 0.428325E+07-0.880000E+02-0.360000E+02
 0.200000E-02 0.316000E+00 0.376000E+00 0.220000E+00 0.500000E+02 0.101000E+03
 0.750718E+06 0.854120E+05 0.721991E+06 0.428335E+07-0.980000E+02-0.350000E+02
 0.200000E-02 0.276000E+00 0.396000E+00 0.220000E+00 0.100000E+03 0.800000E+01
 0.750718E+06 0.854170E+05 0.721985E+06 0.428345E+07-0.840000E+02-0.440000E+02
 0.200000E-02 0.184000E+00 0.400000E+00 0.320000E+00 0.100000E+03 0.500000E+01
 0.750718E+06 0.854240E+05 0.721977E+06 0.428360E+07-0.760000E+02-0.340000E+02
 0.200000E-02 0.318000E+00 0.380000E+00 0.320000E+00 0.150000E+03 0.700000E+01
 0.750718E+06 0.854310E+05 0.721982E+06 0.428375E+07-0.980000E+02-0.360000E+02
 0.200000E-02 0.366000E+00 0.358000E+00 0.320000E+00 0.150000E+03 0.700000E+01
 0.750718E+06 0.854370E+05 0.721989E+06 0.428389E+07-0.940000E+02-0.360000E+02

 25 RECORDS AT END OF FILE

 0.120000E-01 0.142000E+00 0.462000E+00 0.220000E+00 0.200000E+03 0.110000E+02
 0.750718E+06 0.181017E+06 0.806740E+06 0.420640E+07-0.150000E+03-0.180000E+03
 0.120000E-01 0.156000E+00 0.452000E+00 0.320000E+00 0.200000E+03 0.370000E+02
 0.750718E+06 0.181031E+06 0.806545E+06 0.420645E+07-0.150000E+03-0.180000E+03
 0.120000E-01 0.236000E+00 0.450000E+00 0.220000E+00 0.200000E+03 0.140000E+02
 0.750718E+06 0.181043E+06 0.806346E+06 0.420647E+07-0.150000E+03-0.180000E+03
 0.120000E-01 0.170000E+00 0.414000E+00 0.100000E+00 0.200000E+03 0.120000E+02
 0.750718E+06 0.181055E+06 0.806147E+06 0.420649E+07-0.150000E+03-0.180000E+03
 0.120000E-01 0.176000E+00 0.416000E+00 0.220000E+00 0.200000E+03 0.120000E+02
 0.750718E+06 0.181107E+06 0.805948E+06 0.420651E+07-0.150000E+03-0.180000E+03
 0.120000E-01 0.156000E+00 0.428000E+00 0.220000E+00 0.200000E+03 0.120000E+02
 0.750718E+06 0.181118E+06 0.805749E+06 0.420653E+07-0.150000E+03-0.180000E+03
 0.120000E-01 0.170000E+00 0.438000E+00 0.220000E+00 0.200000E+03 0.110000E+02
 0.750718E+06 0.181129E+06 0.805550E+06 0.420656E+07-0.150000E+03-0.180000E+03
 0.120000E-01 0.136000E+00 0.450000E+00 0.220000E+00 0.200000E+03 0.110000E+02
 0.750718E+06 0.181140E+06 0.805351E+06 0.420658E+07-0.150000E+03-0.180000E+03
 0.120000E-01 0.128000E+00 0.444000E+00 0.220000E+00 0.200000E+03 0.110000E+02
COMMENTS:
(1) COSPEC-SO2 REPRESENTS VERTICALLY INTEGRATED BURDEN OF SO2 ABOVE THE
    AIRCRAFT FLIGHT ALTITUDE. THE COSPEC VIEWER WAS AIMED UPWARD.
(2) THE UTM X-Y DATA ARE REFERRED TO UTM ZONE 15.
(3) DELTA-D = DISTANCE FROM LOCATION AT LAST RECORD
    DELTA-T = TIME SINCE LAST RECORD


TOTAL OF 6284 RECORDS IN FILE EMI75.718
```

```
 25 RECORDS AT BEGINNING OF FILE

20    2  13  ANL76                              30. MINUTES
MISTT 1976                          ANL         MICROMETEOROLOGY DATA
(8F10.1,/,5F10.1,30X)
DATE       TIME       TOTRAD     NETRAD     H0         U*A        U*B        WS
WD         A?         TEMP       TWET       CODE
YYMMDD     HHMM,CDT   W/M**2     W/M**2     W/M**2     CM/S       CM/S       CM/S
DEG-CWN               DEGC       DEGC
      208
  770000.0  340000.0    1000.0    1000.0     300.0     100.0     100.0    1000.0
     360.0      50.0      50.0      50.0      10.0
  750000.0       0.0       0.0       0.0    -100.0       0.0       0.0       0.0
       0.0       0.0       0.0       0.0       0.0
  760716.0    1600.0     512.0 -100000.0 -100000.0 -100000.0 -100000.0     600.0
     360.0 -100000.0      24.4      18.4 -100000.0
  760716.0    1630.0     512.0 -100000.0 -100000.0 -100000.0 -100000.0     550.0
     340.0 -100000.0      24.4      18.4 -100000.0
  760716.0    1700.0     465.0 -100000.0 -100000.0 -100000.0 -100000.0     550.0
     350.0 -100000.0      24.4      18.2 -100000.0
  760716.0    1730.0     326.0 -100000.0 -100000.0 -100000.0 -100000.0     600.0
     350.0 -100000.0      23.9      17.6 -100000.0
  760716.0    1800.0     233.0 -100000.0 -100000.0 -100000.0 -100000.0     500.0
     350.0 -100000.0      23.3      17.2 -100000.0
  760716.0    1830.0     140.0 -100000.0 -100000.0 -100000.0 -100000.0     450.0
     360.0 -100000.0      22.8      17.0 -100000.0
  760716.0    1900.0      47.0     -51.0 -100000.0 -100000.0 -100000.0     250.0

 25 RECORDS AT END OF FILE

  760730.0     630.0 -100000.0 -100000.0 -100000.0 -100000.0 -100000.0 -100000.0
 -100000.0 -100000.0 -100000.0 -100000.0 -100000.0
  760730.0     700.0 -100000.0 -100000.0 -100000.0 -100000.0 -100000.0 -100000.0
 -100000.0 -100000.0 -100000.0 -100000.0 -100000.0
  760730.0     730.0 -100000.0 -100000.0 -100000.0 -100000.0 -100000.0 -100000.0
 -100000.0 -100000.0 -100000.0 -100000.0 -100000.0
  760730.0     800.0 -100000.0 -100000.0 -100000.0 -100000.0 -100000.0 -100000.0
 -100000.0 -100000.0 -100000.0 -100000.0 -100000.0
  760730.0     830.0 -100000.0 -100000.0 -100000.0 -100000.0 -100000.0 -100000.0
 -100000.0 -100000.0 -100000.0 -100000.0 -100000.0
  760730.0     630.0 -100000.0 -100000.0 -100000.0 -100000.0 -100000.0 -100000.0
 -100000.0 -100000.0 -100000.0 -100000.0 -100000.0
  760730.0     700.0 -100000.0 -100000.0 -100000.0 -100000.0 -100000.0 -100000.0
 -100000.0 -100000.0 -100000.0 -100000.0 -100000.0
  760730.0     730.0 -100000.0 -100000.0 -100000.0 -100000.0 -100000.0 -100000.0
 -100000.0 -100000.0 -100000.0 -100000.0 -100000.0
  760730.0     800.0 -100000.0 -100000.0 -100000.0 -100000.0 -100000.0 -100000.0
 -100000.0 -100000.0 -100000.0 -100000.0 -100000.0
(1) TOTRAD = BROADBAND RADIATION
(2) NETRAD = NET RADIATION
(3) H0 = SENSIBLE HEAT FLUX
(4) U*A AND U*B ARE FRICTIONAL VELOCITIES DETERMINED BY TWO
    DIFFERENT METHODS. FOR DETAIL, SEE p.35 OF ANL REPORT:
    HICKS ET AL. (1981). THE SANGAMON FIELD EXPERIMENTS. ANL/RER-81-1.
(5) WS, WD, TEMP, AND TWET ARE AT 1.3 m AGL.

TOTAL OF  435 RECORDS IN FILE ANL76.DAT
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